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ASTM Bulletin

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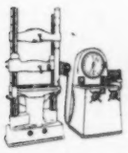

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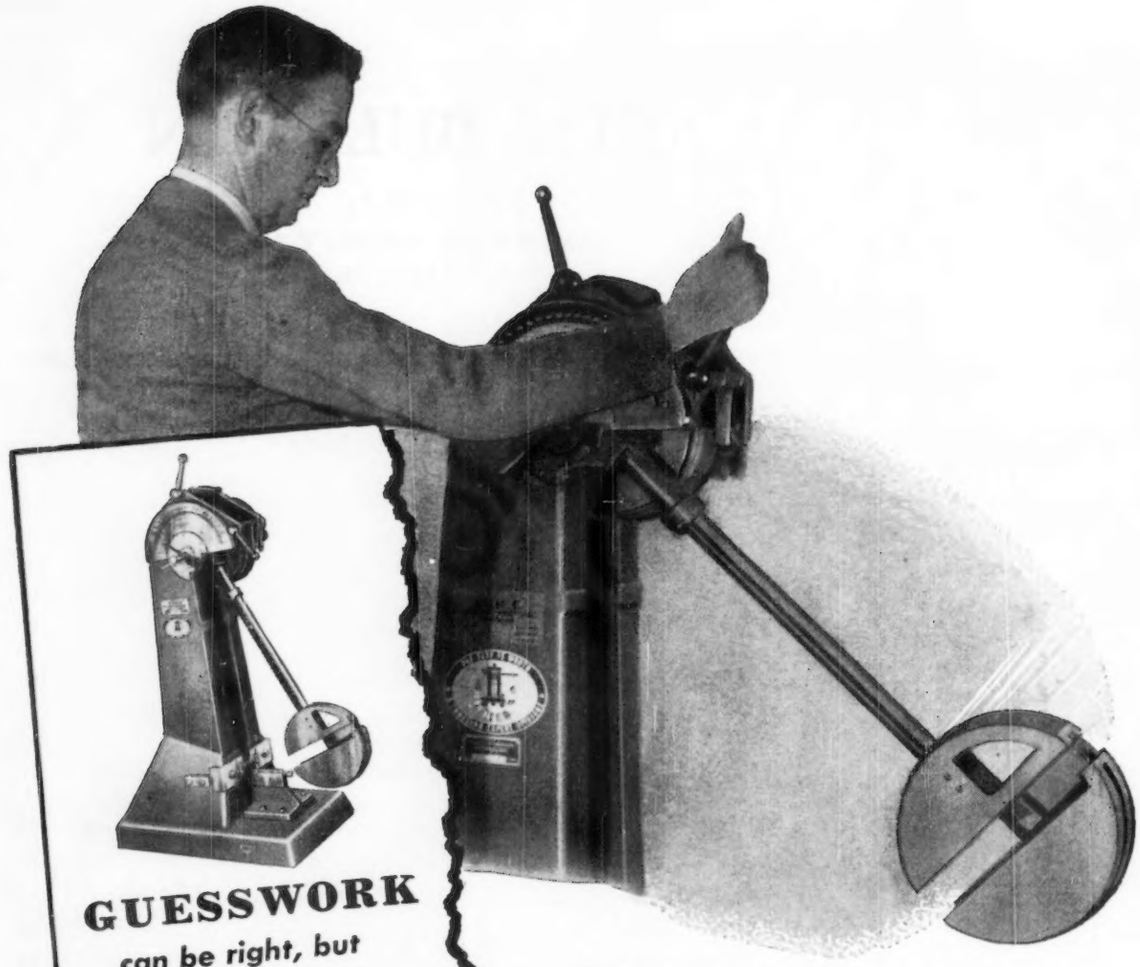

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"Promotion of Knowledge of Materials of Engineering, and Standardization of Specifications and Methods of Testing"

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CABLE ADDRESS—TESTING

Number 136 October 1945

Several New Specifications and Testing Procedures Accepted

Administrative Committee on Standards Acts at August Meeting

SEVERAL important new specifications and testing procedures for widely used materials were accepted by the Society, through action of the Committee on Standards at its August 27 meeting. Also, numerous revisions were approved for publication in existing formal standards and tentatives. Groups of recommendations came from technical committees on electrical deposited metallic coatings; metal powders and powder products; paint, varnish, lacquer, and related materials; shipping containers; and water for industrial uses; also the committee responsible for methods of chemical analysis of metals.

All of these specifications, both new and revised, will be published during the Fall, and in addition to being available separately will be included in the 1945 Supplement to the Book of Standards which will be issued late in December. The accompanying table lists the various actions.

Electrodeposited Coatings

While the new specifications covering coatings of lead on steel are essentially the same as the Emergency ES – 31, they have been revised and modernized. Six types of coatings are covered, with thickness ranging from 0.0010 in. to 0.00055. The tests which are specified include the salt spray (B 117), thickness, requirements on number of tests, selection of samples, etc.

The new Specifications for Chromate Finishes on Electrodeposited Zinc Hot-Dipped Galvanized, and Zinc Die-Cast Surfaces (B 201–45 T) provide requirements for such finishes as are produced by chemical or electrochemical methods from solutions containing chromates or chromic acid. The specifications cover only the protective value of the supplemental films and not the other properties or their composition or method of application. The revised Specifications for Electrodeposited Coatings of Nickel and Chromium on Steel (A 166) include a fourth type of coating with a minimum thickness for copper plus nickel of 0.0020 in. Added to the Test Methods A 219 are the less accurate but commercially used magnetic methods and the dropping test. Other revised specifications cover coatings of nickel and chromium on zinc and zinc-base alloys (B 142) and recommended practice for chromium plating on steel for engineering use (B 177).

Metal Powders and Metal Powder Products

Committee B-9 on Metal Powders and Metal Powder Products is one of the newer technical groups of the Society and the new specifications covering metal powder sintered bearings (oil impregnated) (B 202) are its first recommendation. The committee has held numerous meetings to discuss its work and get it on a sound technical basis, and additional methods and specifications are expected from time to time. In the new tentative two types of bearings are provided for: bronze-base and iron-base, with two classes in each. Class A, bronze-base, has a range of copper of 87.5 to 90.5 per cent; tin, 9.5 to 10.5; carbon, 1.5 max., and a maximum of other elements of 0.5. In comparison, Class B requires 82.6 to 88.5 copper; 9.5 to 10.5 tin, and in addition shows maximum permissible quantities of 2.0 to 4.0 per cent lead; 0.75 zinc; 0.35 nickel; 0.25 antimony. Class A, iron Type II, has a minimum of 95.0 iron; carbon can range from 0.5 to 2.0, with other elements 3 per cent maximum. For Class B the copper range is from 5 to 30 per cent with total iron plus copper not less than 97 per cent. Requirements are given on maximum number of pieces in a lot, which is the quantity used in the provisions for the number of tests required both for chemical analysis and the physical tests. The density in grams per cubic centimeter ranges from 5.7 to 6.9 max. for the various classes and types. Porosity in terms of interconnected void space by volume shall be not less than 18 per cent for all classes. There has been evident a real need for specification requirements and Committee B-9 feels this new A.S.T.M. tentative will be helpful.

Paint, Varnish, Lacquer, and Related Products

Of the three new methods developed by Committe D-1 on Paint, Varnish, Lacquer, and Related Products, one is a test for evaluating degree of resistance of traffic paints to abrasion (D 821); another gives procedures for producing films of uniform thickness of organic finishing materials on test panels (D 820) and the third is a recommended practice for operating light and water exposure apparatus (carbon-arc type) for testing paint, varnish, lacquer, and related products (D 822). The traffic paint abrasion test is based on the use of photographic reference standards and the four illustrations give degrees ranging from two to eight. The method

indicates that while gradings between the standards may be interpolated, the accuracy by visual means would not warrant interpolations in less than unit steps.

The method for producing films of uniform thickness of organic finishing materials on test panels (D 820) has three procedures: An automatic spraying machine which makes use of a spray gun moved over the test panel at an arbitrarily selected rate; an automatic dip coater which includes a mechanism to withdraw a panel from a tank at a predetermined rate; and third, an automatic doctor blade applicator which is filled with the paint and is then allowed to slide down an inclined test panel under carefully prescribed conditions. The other new Committee D-1 method (D 822) is intended to establish means for uniform operation of light and water exposure apparatus of the carbon-arc type, which is sometimes referred to as accelerated or artificial weathering apparatus.

Numerous revisions were accepted in various pigment specifications and other paint material standards as detailed in the 1945 preprinted report of the committee. These changes will bring the specifications more up to date and in some instances permit a small percentage of surface treating agents. The materials involved include: pure chrome green, chrome oxide green, Prussian blue, ultramarine blue, titanium dioxide pigments, bone black, carbon black, lampblack. Other materials covered by existing standards which were revised include alkyd resin solutions (D 563); house paints and enamel-type paints (D 562); preparation of steel panels for exposure tests of enamels (D 609).

Shipping Containers

Because of the intense interest in shipping containers and the desirability of having standardized methods of testing, A.S.T.M. Committee D-10 on Shipping Containers was reorganized earlier this year and has several methods under study, two of which have now been issued as A.S.T.M. tentatives covering compression testing and a drop test. These methods, D 642, compression, and D 775, drop, have been issued as revisions of two existing tests which, however, applied only to fiberboard containers.

Industrial Waters

Committee D-19 on Water for Industrial Uses has issued several standard methods of determining various elements and ions in industrial waters and the three new methods accepted by the Society cover total aluminum and aluminum ion in industrial waters (D 857), manganese (D 858), and silica (D 859). In general these methods are intended to provide procedures from which the quality of water may be judged and to control water treatment operations. The method for silica is particularly important in boiler operations so that measures can be taken to prevent the formation of complex silicate scales and to reduce the tendency of the "embrittlement" of boiler metal. The new tentative recommended practice for sampling boiler water for stationary boilers (D 860) is another phase in the program to establish recognized methods for sampling in order to obtain the necessary analytical information to judge the quality of water.

Tests for Dissolved Oxygen in Industrial Waters.—Numerous technical papers and reports have covered procedures for testing for dissolved

Actions by the Administrative Committee on Standards, August 27, 1945

New Tentatives

Specifications for:
- Electrodeposited Coatings of Lead on Steel (B 200 – 45 T)
- Chromate Finishes on Electrodeposited Zinc, Hot-Dipped Galvanized, and Zinc Die-Cast Surfaces (B 201 – 45 T)
- Metal Powder Sintered Bearings (Oil Impregnated) (B 202 – 45 T)

Methods of:
- Chemical Analysis of Soaps Containing Synthetic Detergents (D 820 – 45 T)
- Evaluating Degree of Resistance of Traffic Paint to Abrasion, Erosion, or Combination of Both, in Road Service Tests (D 821 – 45 T)
- Compression Test for Shipping Containers (D 642 – 45 T)
- Drop Test for Shipping Containers (D 775 – 45 T)
- Test for Total Aluminum and Aluminum Ion in Industrial Waters (D 857 – 45 T)
- Test for Manganese in Industrial Waters (D 858 – 45 T)
- Test for Silica in Industrial Waters (D 859 – 45 T)
- Chemical Analysis of Steel, Cast Iron, Open-Hearth Iron, and Wrought Iron (E 30 – 45 T)
- Photometric Determination of Bismuth in Pig Lead (E 58 – 45 T)

Recommended Practice for:
- Operating Light and Water Exposure Apparatus (Carbon-Arc Type) for Testing Paint, Varnish, Lacquer, and Related Products (D 822 – 45 T)
- Sampling Boiler Water from Stationary Boilers (D 860 – 45 T)

Tentative Revisions of Standards

Specifications for:
- Pure Chrome Green (D 212 – 41)
- Chrome Oxide Green (D 263 – 41)
- Prussian Blue (D 261 – 41)
- Ultramarine Blue (D 262 – 41)
- Titanium Dioxide Pigments (D 476 – 41)
- Bone Black (D 210 – 41)
- Carbon Black (D 561 – 41)
- Lampblack (D 209 – 41)

Methods of:
- Chemical Analysis of White Pigment (D 34 – 39)
- Test for Consistency of Exterior House Paints and Enamel-Type Paints (D 562 – 44)

Revision of Tentatives

Specifications for:
- Electrodeposited Coatings of Nickel and Chromium on Steel (A 166 – 45 T)
- Electrodeposited Coatings of Nickel and Chromium on Copper and Copper-Base Alloys (B 142 – 45 T)
- Asphalt Roofing Surfaced with Coarse Mineral Granules (D 249 – 45 T)
- A.S.T.M. Thermometers (E 1 – 45 T) (Approved Sept. 29, 1945)

Methods of:
- Test for Local Thickness of Electrodeposited Coatings (A 219 – 45 T)
- Test for Phthalic Anhydride Content of Alkyd Resin Solutions (D 563 – 45 T)
- Preparation of Steel Panels for Testing Paint, Varnish, Lacquer, and Related Products (D 609 – 45 T)

Recommended Practice for:
- Chromium Plating on Steel for Engineering Use (B 177 – 45 T)

Standard and Tentative Methods Withdrawn

Methods of:
- Compression Test for Shipping Containers (D 642 – 43)
- Drop Test for Shipping Containers (D 775 – 44 T)

Revision of Emergency Alternate Provision

Specifications for:
- EA – D 249c Asphalt Roofing Surfaced with Coarse Mineral Granules (D 249 – 45 T)

Withdrawal of Emergency Standard

Specifications for:
- Electrodeposited Coatings of Lead on Steel (ES – 31)

oxygen and after considerable study the subcommittee concerned proposed a standard test which included a method for referee and three non-referee procedures. The method of highest precision and accuracy was intended for acceptance testing of deaerating and for research testing of power plant equipment.

Because of numerous comments and some negative votes, it is planned to publish the proposed methods as information and for comment in the December BULLETIN. All those concerned are invited to study the methods and submit discussion to Committee D-19 for consideration.

METHODS OF CHEMICAL ANALYSIS OF METALS

Two new methods involving determination of certain elements in metals were accepted through the work of A.S.T.M. Committee E-3 on Methods of Chemical Analysis: One, E 58, gives new standards for checking bismuth in pig lead based on modern technique; the other method to be part of the extensively used chemical analysis of steel, E 30, covers the determination of nitrogen.

In connection with the photometric methods for bismuth in lead the committee has virtually completed another proposed tentative which would give requirements on apparatus, equipment, etc., used in photometric procedures to which references will be made in the new Method E 58.

The analytical procedure for nitrogen resulted from extensive cooperative research in the committee whereby the proposed test was compared by several members with different procedures in use including in some cases their own modifications. As a result of work on eleven steels and alloys containing nitrogen from about 0.234 to 0.0046 per cent the new methods were demonstrated to be satisfactory.

Many New A.S.T.M. Projects Being Undertaken

AT NO time in the Society's history have there been so many important new projects under way. Apart from reorganization of the administrative setup referred to elsewhere in this BULLETIN and in the annual report of the Executive Committee, action was taken at the recent meeting of the Executive Committee authorizing a number of new technical committees. Two of these, a committee dealing with methods of testing building constructions and another with fatigue, the latter an extension of the activities of the Research Committee on Fatigue of Metals, are referred to elsewhere as having been recommended by the Administrative Committee on Simulated Service Testing.

In addition, on the recommendation of the Committee on Standards, a new committee on asbestos-cement products is being set up and steps are being taken looking toward the organization of a new committee on oxychloride-cement. Consideration is being given to the recommendation of the Administrative Committee on Ultimate Consumer Goods that a committee on methods of testing antifreeze solutions be organized. Members may expect to receive a further announcement in subsequent issues of the BULLETIN with respect to these latter committees.

Important Changes in Nomenclature

WHILE the changes in terminology with respect to the Society's committees may not be very noticeable to members, etc., who read the Year Book and committee material in the BULLETIN, they are most significant. As detailed in the 1945 Executive Committee Report it was contemplated that there would be four general classifications of the committees—technical, administrative, special, and district. Members and the staff have been so accustomed to speaking of "standing committees" that it is difficult to think of a terminology which differentiates clearly between technical and administrative committees. Most A.S.T.M. committees are "standing" ones and there is now a clear differentiation between administrative committees, such as the ones on standards, research, papers and publications, etc., which formerly carried "E" designations and the strictly technical committees which function in the A, B, C, and D, and some in the E group. New administrative committees have been formed, as announced in detail in earlier BULLETINS, covering simulated service testing, district activities, ultimate consumer goods, etc.

While it is somewhat premature to refer to the proposed changes in nomenclature of district committees, there is under way in the administrative committee in this field the development of a revised charter and related materials which envisages the organization of a "district" such, for example, as a Chicago District, with the directing group to be an executive group or governing board or some similar title which actually would be what we now call a "district committee." The Executive Committee has, in principle, approved this new concept but awaits detailed recommendations from the Administrative Committee.

"TENTATIVES" FOR TENTATIVE STANDARDS

In an effort to establish a very clear distinction between the formally adopted specifications and tests and what have heretofore been called "tentative standards," the term "tentatives" will now apply to proposed standards issued for trial and comment and the term "standard" after these tentatives have been adopted. Even though when a proposed specification or test method is first published by the Society it has gone through a rigorous procedure of subcommittee and committee discussion and ballot, and acceptance by the Society at an annual meeting or by the Administrative Committee on Standards, there are many who feel that nothing will quite establish and justify the requirements as

to have a period of use and trial. A.S.T.M. tentatives are very widely used and for many people there is little distinction between a tentative and a standard so far as acceptability is concerned, but the need for carrying this distinction is apparent, hence the change in nomenclature.

The distinction too may aid in clarifying an erroneous impression which some have that when a revision of a standard is proposed and accepted for publication the standard automatically reverts to the status of a tentative. This is not the case. The tentative revisions are published for trial, usually in the back of the Book of Standards, and they have no standing until on the recommendation of the technical committee involved they are adopted and incorporated in the standard. In connection with the publication of specifications and tests as separate pamphlets it is now the policy to publish the tentative revisions of standards as editorial notes at the end of the standard.

International Discussion of Standards

STEPS have recently been taken looking toward the organization of a new international standards organization. Since the activities of the International Standards Association had of necessity been suspended, the United Nations Standards Coordinating Committee has been functioning recently in an interim capacity. An organization, however, will now need to be set up to function on a peacetime basis. With this in mind, there was held in New York over the dates of October 8 to 10, 1945, a conference at which representatives of the following United Nations were present for the purpose, first, of reviewing the work of the UNSCC for the year during which it has been in existence and, second, to consider the framework of a constitution and method of organization of a superseding international organization:

Australia	China	Mexico
Belgium	Denmark	South Africa
Brazil	France	United States
Canada	Great Britain	

The United States was represented through the American Standards Association.

Certain proposals were agreed upon which in due time will be referred to all of the national standardizing bodies and so far as this country is concerned, all member bodies of the ASA will have an opportunity to consider them.

Preparatory to the conference, the Board of Directors of the ASA appointed a special committee in order to consider from the American point of view certain aspects of international cooperation in standardization work and the recommendations of this committee were placed in the hands of the American delegate for his use. The Executive-Secretary of the Society, C. L. Warwick, served as a member of this special committee:

H. S. Osborne, *Chairman*	R. L. DeGroff
L. F. Adams	Preston S. Millar
Howard Coonley	J. A. C. Warner
E. C. Crittenden	C. L. Warwick
C. E. Davies	R. E. Zimmerman

Representatives of:

Bureau of Foreign & Domestic Commerce
U. S. State Department
U. S. Tariff Commission

New Federal Specifications Board

THE MANY members who are concerned with Federal specifications will be much interested in the establishment of the new Federal Specifications Board. This Board, composed of representatives from ten Government agencies, is charged with the preparation and revision of purchase specifications for supplies used by all Executive departments and agencies. Such specifications are subject to the approval of and promulgation by the Director of Procurement.

The Board is composed of representatives designated respectively by the heads of the following agencies:

Treasury Department
War Department
Post Office Department
Navy Department
Interior Department
Agriculture Department
Commerce Department
Veterans Administration
Federal Security Agency
Federal Works Agency

and representatives of such additional agencies as the Director of Procurement may from time to time provide.

Functioning under the new Board are some 74 technical committees which include in their personnel technologists from various Government divisions. There are some 1300 experts on the committees who are charged with drafting the requirements on quality and performance of a wide variety of materials and equipment. Drafts of proposed specifications will be submitted for comment and criticism to Government agencies, representative manufacturers, and recognized technical and professional societies. Among the latter listed by the Board are the American Standards Association, the American Society for Testing Materials, the Society of Automotive Engineers, the American Society of Civil Engineers, The American Society of Mechanical Engineers, the National Institute of Governmental Purchasing, and others. In this way, all interested parties will be given the opportunity to comment on any proposed specification. The Technical Committees will then incorporate any accepted suggestions in the final draft of a specification.

Initiation or revision of a Federal specification may be recommended by any member of the Board or the Technical Committees, any Government agency, or by industry. The Vice-Chairman of the Board will then determine, with the advice of Board members, whether the facts justify a specification.

Through the establishment of these uniform specifications unnecessary grades and varieties are eliminated and large savings are effected on Government purchases.

Chairman of the Federal Specifications Board is Dr. Lyman J. Briggs, Director of the National Bureau of Standards. Executive Vice-Chairman is Willis S. MacLeod, Acting Deputy Director of the Standards Branch of the Procurement Division.

An Automotive Tire Fatigue Machine

By John N. Kenyon[1]

SYNOPSIS

A tire fatigue machine is developed and data obtained which indicate that the speeding pneumatic tire is subjected to the greatest dynamical stress at the top or 180 deg. from the point of contact with the roadbed.

Theory is advanced that a "standing" sinusoidal type wave builds up in the perimeter of the speeding tire and attains its maximum surge at the top or undampened part of the tire structure. Simultaneously a complementary wave system is set up in the sidewalls and results in an ultimate cracking up, "oxidation fatigue," of the protective rubber covering.

THIS study is a progress report and the "wave" theory of tire breakdown will be verified or modified in a later and more comprehensive investigation. To that end an improved fatigue machine is being constructed.

AN ANALOGY

In the late twenties the attention of the railroad and steel interests was called to an indicated upward trend in rail fatigue breaks. This trend, though not accompanied by an increase in fatal accidents, was nevertheless an indication of a future potential danger. Consequently a comprehensive investigation was undertaken at the University of Illinois under the direction of H. F. Moore.[2] This important study (probably costing some $500,000), together with the work performed by the A.R.E.A. and Sperry detector cars, has largely eliminated rail fatigue failures from any contribution to railroad accidents. The study was most opportune in view of the increased rail tonnage contingent on the war transportation and its importance is best summarized in a statement by A. G. Trumball of the Chesapeake & Ohio Railroad: "A research typical of the very best that can be done and one of tremendous value to the railroads of America."[3]

NEED FOR A TIRE FATIGUE MACHINE

In view of the far-reaching importance of the Illinois rail fatigue investigation, some thought was given to a parallel study that might contribute to the automotive traffic problem. It seemed reasonable to assume that *a sound tire is as vital to the safety of a speeding car as a sound rail is vital to the safety of a speeding train.* While no off-hand conclusion was drawn as to what extent tire failures contributed to highway accidents, as in the case of rails, it was assumed that the matter was worthy of careful consideration. The proposed study offered certain inherent difficulties not usually encountered in the usual run of fatigue problems:

1. Construction of a tire fatigue machine that would simulate the *low amplitude-high frequency* vibrational effects encountered on the highways,
2. Extension of the study of the fatigue of metals into the field of organic materials, and
3. Possible coining of the term "oxidation fatigue" of rubber to be synonymous with the corrosion fatigue of metals.

The development of a tire fatigue machine that might give positive indication of fabric and rubber endurance would have important implications:

1. *Design.*—It is an entirely new concept (brought out by this study) that the speeding tire is more severely stressed at the top than where it contacts the roadbed.
2. *Natural versus Synthetic Rubbers.*—The endurance properties of the organic materials, especially in the finished processed condition, is largely an unexplored field.
3. *Performance versus Environment.*—While laboratory tests do not entirely simulate service behaviors, they do give valuable comparative data on the separate effects of repeated stress, temperature, humidity, etc.
4. *Safety.*—The State highway departments need more positive test methods whereby potentially dangerous tires can be detected and retired from service.

CAUSE AND EXTENT OF HIGHWAY ACCIDENTS

There is no agency, governmental or private, whereby the cause of all highway accidents can be accurately determined. This is due in part to the overlapping of jurisdictions, inadequate data-gathering techniques, and the fact that the accident itself may destroy the evidence of cause. The extent to which tire defects contribute to these accidents is a matter for wide divergence in opinion. A New York City official states positively that tire failures play no essential part in street accidents and that they are mainly due to "skidding and going out of control." This statement probably holds to large extent for all congested areas where speeds are under rigid control. On the other hand, some state officials believe that up to 10 per cent of their highway accidents can be charged to tire blowout. These are no doubt contingent on the higher speeds, the rounding of curves, and especially "cutting in" which calls for burst of speeds on unbanked stretches of highways.

THEORY OF THE MACHINE

The pneumatic tire is an elastic composite fabrication consisting of rubber, fabric, steel wire, and a torus of compressed air. In service it is subjected to high frequency cyclical forces and the ever-present element of chemical decay. The dynamical stresses set up in the tire are highly complex and in large degree indeterminate. The best approach to a solution of the magnitude of these stresses, it would seem,

---

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to A.S.T.M. Headquarters, 260 S. Broad St., Philadelphia 2, Pa.

[1] Research Engineer, Columbia University, New York, N. Y.

[2] Herbert F. Moore, "Joint Investigation of Fissures in Railroad Rails," (Progress Reports 1931-1944) *Bulletins* of the University of Illinois.

[3] R. E. Cramer, "Metals for Railroads," *Metal Progress*, March, 1945, p. 521.

Fig. 1.—Sine-Type Wave Pattern Set Up in a Loosely Taut Belt.

The wave travels rapidly back and forth with each element in the belt moving up and down.

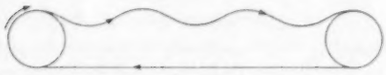

Fig. 2.—A "Standing Wave" in the Slack Side of a Moving Belt.

Here each element in the belt follows the path of the wave pattern.

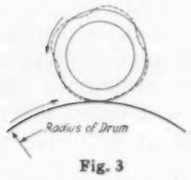

Fig. 3

Fig. 4

Fig. 3.—The Stroboscope Shows the Perimeter of a Tire Speeded on a Drum to Be a "Standing Wave."

Fig. 4.—Wave Motion Set Up in Tire as a Result of Vibration on an Oscillating Platform (Theoretical).

is to make an elementary assumption of mass-stress effect and attempt to develop therefrom a mathematical relation. Some data will now be presented to show that a wave surge develops in the speeding tire and that it may eventually be possible to express the nature of this wave in mathematical terms.

Consider a length of belt attached to a rigid support with the free end held taut and moved rapidly up and down (see Fig. 1). A sine-type wave builds up in this belt and travels rapidly to and fro.

Consider a belt that is endless and mounted on fast driven pulleys (see Fig. 2). It very often happens that a "standing wave" builds up in the slack side of this belt and may persist for hours.

Now take the case of the pneumatic tire driven on a drum. The stroboscope reveals that a wave effect, more or less standing, is set up in the perimeter or tread of this tire (see Fig. 3).

Finally, suppose that this tire is not rotated but is vibrated on an oscillating platform (see Fig. 4). It is entirely conceivable that a wave motion is set up in the tread at the point of contact, is propagated, and attains its maximum surge at the top or *undampened* portion of the tire structure. This wave, if assumptions are correct, travels very rapidly and is analogous to the sine-type wave exemplified in Fig. 1. By the same line of reasoning the wave pattern set up in the rapidly rotating tire is analogous to the "standing wave" of Fig. 2.

It is a well-established mathematical principle that two or more dynamical effects can proceed within an elastic material entirely independent of each other. For instance, two disturbances on the surface of a pool will produce wave rings that meet and pass at uninterrupted speeds. The tidal wave surge produced in the earth's crust is not necessarily a function of its rotation, for if the earth were fixed and the moon revolved about it every twenty-four hours there would be produced a similar tidal wave surge. By the same token an automotive tire can be subjected to a pulsational wave effect while standing still (or rotating slowly) and thus duplicate the wave surge contingent on high speeds. The one is a more or less "standing wave" while the other is a "tidal" wave. When reproduced and analyzed they probably will be found to be similar in pattern.

Development of the Tire Fatigue Machine

A large reinforced wooden platform, Fig. 5, is balanced on a $1\frac{1}{4}$-in. steel ball and one edge of this platform is attached to the flywheel of a lathehead by means of a self-aligning ball bearing. The ball race is assembled within the flywheel and fitted with a micrometer offset arrangement whereby the platform can be given an oscillating motion.

Three tires mounted on half axles are attached to a triangular steel casting which is centered on the wooden platform by means of a vertically sliding thrust rod. One end of this rod contacts a steel ball within the triangular casting and a 2400-lb. load is applied to the upper end through a truss with two 4:1 levers and two 300-lb. weights. Each tire therefore carries a *steady* load of 800 lb. The fatigue machine is driven by a $\frac{1}{2}$-hp. motor at 1800 r.p.m.

It is to be especially noted in this experimental machine that the tires do *not* rotate and are only accelerated vertically by the oscillating motion. The final design embodies a turntable on the wooden platform whereby the tires would be rotated slowly in order to give an ever-changing point of contact. It is to be further noted that the speed of the motor (1800 r.p.m.) does not necessarily have a direct re-

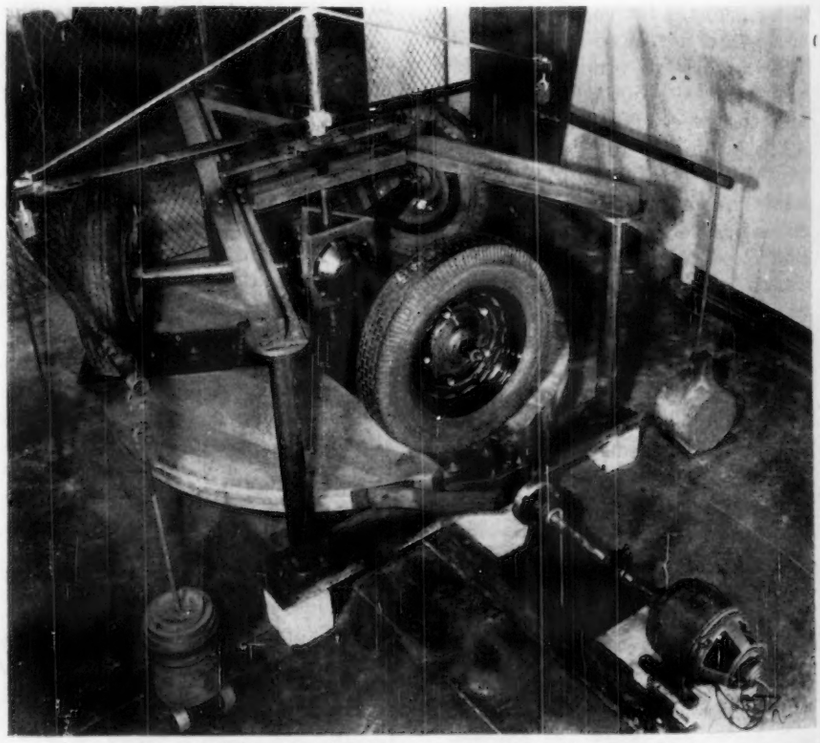

Fig. 5.—Fatigue Testing Apparatus Loaded with Three Tires.

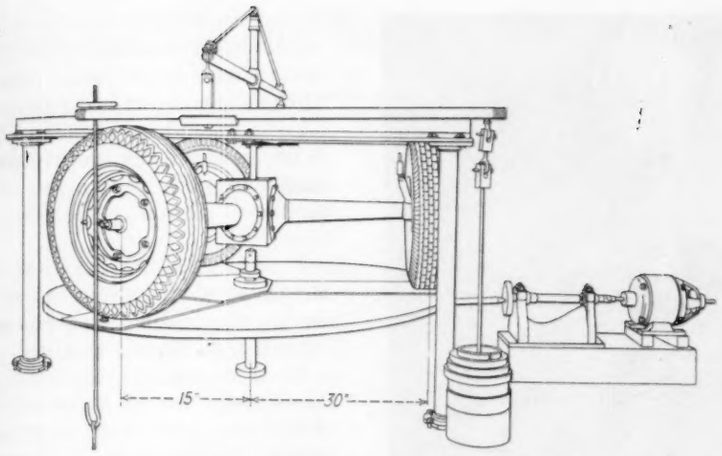

Fig. 6.—Diagrammatic Sketch of the Machine.
The ultimate design calls for a turntable whereby the tires are slowly rotated to give an ever-changing point of contact with the oscillating platform.

lation to the number of miles that the tire might travel on the highway. This speed was arbitrarily chosen as one that might best simulate the *low amplitude - high frequency* vibration produced by irregular roadbeds.

When the machine is operated, the tire nearest the motor is accelerated vertically 180 deg. *out of phase* with the other two tires acting as counters. This arrangement exerts a constant torque on the motor which has only to overcome friction. The apparatus is essentially a pulsating compression machine quite similar in principle to the 3-phase pulsating-tension wire fatigue machine described by the author in 1940.[4]

Referring to Fig. 6, the micrometer offset in the flywheel is adjusted so that the experimental tire assembly (nearest the motor) oscillates about 0.05 in. relative to the platform. This value is estimated with the micrometer microscope when the machine is operated at full speed. Simultaneously the two counter tires, whose projected distance from the center of the oscillating platform is one-half that of the experimental tire, move vertically only 0.025 in. Each tire assembly weighs 90 lb. and for simplicity of calculation it is here assumed that the mass is approximately centered within the wheel itself. The following then is the inertial force exerted on the experimental tire:

$$F = \frac{W \times (2\pi)^2 \times (x)}{32.2 \times T^2 \times 12} = \frac{90 \times 39.5 \times (0.05/2)}{32.2 \times (1/30)^2 \times 12} = 8280 \times (0.050/2) = 200 + \text{lb.}$$

where:

W = weight of tire assembly,
T = period of oscillation = $\frac{1}{30}$ sec., and
x = 0.050/2 in. = $\frac{1}{2}$ vertical travel of tire.

Since the experimental tire already carries a *steady* load of 800 lb. the force acting on it varies 1800 per minute thus:

Total range of force = (800 − 200) to (800 + 200)
= 600 to 1000 lb.

By the same mathematical computation it can be shown that the two counter tires are accelerated under a total force of 200 lb. Since they pulsate 180 deg. out of phase with the experimental tire, the resultant of the force system is always zero and the torque exerted on the motor always constant.[4]

Results of Tests

The experimental fatigue machine was constructed to exemplify the theory that the speeding tire is subjected to the greatest dynamical stress at the top or the undampened portion of the structure. The data obtained, on tires not being rotated, are at the best but qualitative but would seem to bear out the theoretical conception of structural breakdown.

Figure 7 shows a used tire with

Fig. 7.—Three-inch Fatigue Crack and Numerous Smaller Extended Cracks.
Arrow indicates top of tire.

the tread worn nearly smooth. A cut in the sidewall had been vulcanized and fine hairlike cracks were also discernible. According to records, the tire was used on a car always stored in a garage. After about three weeks run in the fatigue machine the sidewall cracks lengthened noticeably and one extended to a length of 3 in. The fabric showing through this sidewall crack appeared to be in good condition. Also near the top (indicated by arrow) a tread leak developed. The rubber sidewall covering appeared loosened near the top of the tire but more in-

[4] John N. Kenyon, "A Pulsating-Tension Fatigue Machine for Small Diameter Wire," *Proceedings*, Am. Soc. Testing Mats., Vol. 40, Part II, p. 762 (1940).

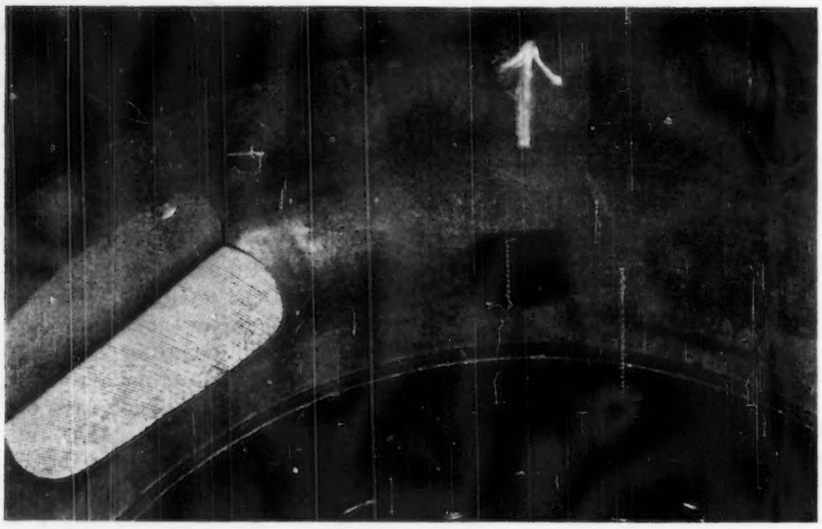

Fig. 8.—Reverse Side of Same Tire Shown in Fig. 7, with a Break in the Rubber Also Near the Top.

tact to the carcass farther down toward the point of contact with the oscillating table.

Figure 8 shows the reverse side of the same tire with a break in the rubber also near the top.

Figure 9 shows a regrooved tire without previous case history. The sidewalls appeared to be in good condition other than a multitude of fine hairlike cracks. This tire failed near the top, due to a blowout after about twenty-four hours run in the fatigue machine. The broken fabric at the edge of break was darkened and somewhat decayed.

It is interesting to note that no appreciable heating effect was detected in the tires even after prolonged runs. This was indicated by the fact that air allowed to escape from the tested tire, and blown directly on a thermometer, was only slightly above room temperature.

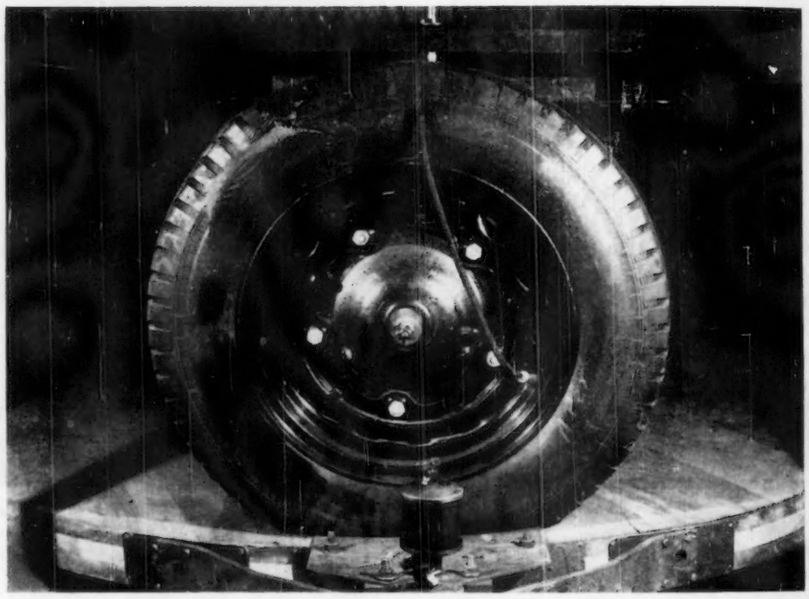

Fig. 9.—Failure Near Top of Tire Due to Blowout.

Conclusions

Due to the limited data this study is being presented as a tentative report. The wave theory of tire failure will be verified or modified in a later and more intensive investigation. To that end a very much improved tire fatigue machine is being constructed. On the basis of the theory and the confirming data certain conclusions are being deduced:

1. A "standing wave" builds up in the speeding tire and reaches its maximum surge at the top or undampened section of the tire structure.
2. The greatest dynamical stress should therefore occur at the top and not at the section constrained by contact with the roadbed.
3. A complementary wave system is also built up in the sidewalls of the tire, ultimately resulting in hairlike "oxidation-fatigue" cracks. These cracks admit contaminated moistures which decay the fabric.
4. If the "standing wave" of the speeding tire can be duplicated by a "tidal wave" surge in a slowly rotated tire then the "fatiguing" effect on the tire structure should be similar.

Mail

Each mail at Headquarters has interesting material—for example, a penny postal card recently received from a southern state merely carrying the address "260 Broad St., Philadelphia, Pa." Presumably what enabled our efficient Philadelphia Post Office to get this to A.S.T.M. was the desire on the part of the writer to get "some testing materials on the seventh grade level." Apparently the writer has 30 seventh-grade pupils, and while we have no doubt that they have done considerable testing on their own, such as the resistance of a window pane to the impact of a well-placed baseball, or what happens to the seat of a pair of trousers when punctured by a Bee-Bee, we doubt that many of the young Americans in the seventh grade will be much concerned with the technical work of A.S.T.M. But perhaps we are wrong!

A.S.T.M. Tests

In its September *Chemical News* the U. S. Industrial Chemicals, Inc., has a short article, with illustrations, covering the use of physical tests in resin research. Some of the illustrations pertain to impact, accelerated weathering, gloss and color, flexibility, and reflectivity. Several of these and other tests which are used in the chemical and protective coatings fields have been standardized by the Society.

Standard Fatigue Tester for Use by the Rayon Manufacturers —Report to Committee D-13[1]

By W. H. Bradshaw[2]

At the July, 1943, meeting of Committee D-13, I was asked "to make a careful study of all the different fatigue testers now in use, to evaluate the nature of their action on yarn and cord and report what he felt the committee should recommend for use by the rayon manufacturers." The objective was to select a method of testing for fatigue resistance which could be accepted by both the rayon producers on the one hand and the tire makers who are the rayon consumers on the other.

A very broad and comprehensive series of tests was outlined which I planned to make in cooperation with various individuals in the pulp, rayon, and tire industries. Further consideration convinced me this was the wrong approach, and much more could be gained by making a careful analysis of each instrument and selecting one by eliminating the less desirable ones. Frankly, the more I study these instruments the more I wonder why we have allowed ourselves to live so long with such unsatisfactory testing equipment.

I have found no fatigue tester which I can recommend be established as a "Standard." Recent events have stimulated a keen interest in the subject in many of the rayon, pulp, and rubber laboratories. Many good ideas have been born which should be nursed to maturity and not stifled. If a standard is set up by A.S.T.M., it will stop most of this work.

Though we cannot recommend a standard, it is very important that every rayon company who makes yarn for tire cords should be able at least to screen out the yarn which will not be satisfactory for tires, and so we will discuss the various testers available in an attempt to indicate the most satisfactory one.

In this discussion, we are concerned with the fatigue of yarn as it takes place in a cord when used in a tire. When the tire maker says the tire has failed from fatigue, he means a crack has formed which started with the inner ply on the sidewall due to flexing, which is maximum in that area and the effect of which is focused at the point of failure. The failure is on the part of the cord which breaks along a more or less sharply defined line which is parallel to the bead, or is in the form of a zigzag, the major axis of which is parallel to the bead. Though this breaking of the cord is caused by a flexing of the sidewall, that fact does not mean it is caused by a flexing of the cord.

Due to the lack of sufficient basic information needed to establish a means for testing fatigue as a specific fundamental property of our cellulose filaments, we are concerned here only with how we can determine whether the material will be satisfactory under the specific conditions found in a tire. We therefore should test cords and should test them as nearly as possible under the conditions met in a tire.

In October, 1933, Mr. Buckwalter, of the U. S. Rubber Co., reported to this committee the results of some very interesting experiments in which he determined the strains in the first ply of an inflated and deflected tire.

To obtain these measurements he first fastened small knots along the cord lines of the inner ply of a 32 by 6 tire at equal intervals to form a repeated diamond pattern completely covering a section of the tire about 18 in. long. He then inserted an inner tube provided with an uncured section which had been swelled with carbon bisulfide and filled the uncured section with portland cement. The tire was then inflated, the uncured section took the impression of the knots and was cured by the heat of setting of the cement. This operation was then repeated with the tire inflated and deflected 1.45 in. The blocks of cement covered by their sections of tube provided accurate maps of the diamond pattern of knots and made possible accurate measurements of the changes which took place due to the deflection of the inflated tire.

The maps showed that the inner ply, along the sidewall where fabric fatigue takes place, was compressed along the cord path, perpendicular to the cord path, along the radial path, and to a slight extent in a circumferential path. In other words, in the area where the cords fail from fatigue, we find only compression in the portion of the tire in contact with the road. Of course, when this section leaves the ground and ceases to be deflected the cords return to a condition of extension under the inflation load.

The maximum compression along the cord path was found to be 10.8 per cent and that along the radial path was 14 per cent. It is important to note that the cord is not only shortened in this area, it is compressed from all sides. The maximum extension along the cord path was found at the crown and amounted to 3.3 per cent.

After these data were obtained, the tire was run under the same conditions of inflation pressure and deflection as used in obtaining the impressions. When the inner ply had not yet started to fail, the cords were removed and broken in a testing machine. It was found that 80 per cent of the breaks occurred at a point in the length of the cord corresponding to a narrow band along the sidewall approximately $\frac{1}{2}$ in. wide and parallel to the bead. This band was the area in which the

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NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to A.S.T.M. Headquarters, 260 S. Broad St., Philadelphia 2, Pa.

[1] Presented at the March, 1944, meeting of Committee D-13 on Textile Materials.

[2] Tubize Rayon Corp., New York, N. Y., formerly with E. I. du Pont de Nemours and Co., Inc., Wilmington, Del.

maps had showed maximum shortening.

Mr. Buckwalter defined fatigue as "the more or less gradual depreciation in cord strength as tire mileage increases," and later on he said, "one criterion of a fatigue tester is that the strains set up in the fabric be such as to produce a progressive loss in tensile strength as the test proceeds to ultimate rupture." This viewpoint is all right provided we add the thought that the cause of the progressive loss in strength simulates that found in a tire. For example, it would not do in our fatigue tester to have the gradual reduction in strength brought about by heat degradation.

Whereas an inner ply cord at the fatigue zone as it goes through the deflection cycle passes from a very small distension through 9 per cent compression and back to the small distension, the outer ply cords at the fatigue zone pass from 3 per cent distension to 4 per cent compression and back again. These latter figures are for under-inflation. In the case of overloading, the outer cord passes from 4 per cent distension through 2 per cent compression and back.

Another important factor is the very short time involved in the deflection cycle. When the 32 by 6 tire runs at 30 m.p.h., it only requires 0.015 sec. for the cord to pass all the way from a small distension to 9 per cent compression and back again.

Evidently the designer of Firestone's "Snap-cycle Stitched-block" tester felt this "snapping" action, which occurs when the cord changes so quickly from distension to compression and back again, is probably the predominating cause of tire cord failure. There is much to indicate that the fatiguing of the sidewall under a given deflection is more a function of the number of cycles than it is a function of the reciprocal of the time consumed in each cycle. In other words, the important factor is the character of the stresses and strains rather than the speed of their application. In fact, I believe a good rayon cord will suffer less from fatiguing when the time of application of the stress is extremely short, as when the tire is run at a higher speed, assuming the temperature remains constant.

When testing steel, the fatigue value is given as that stress below which it will withstand without fracture an infinite number of cycles of stress. One method of determining it, known as the rotating-beam method, is by supporting a reduced section rod at both ends, loading it at each side of the section, and rotating it under this load. This subjects the reduced section to localized repeated alternate distension and compression.

I believe the final mechanism of failure in the case of a rayon cord is quite different from that which transpires in steel because of the great difference in their respective molecular-aggregate structures.

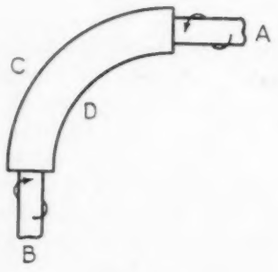

Fig. 1.

With this brief outline of tire fatigue, let us now consider the various testers.

It is obvious that if we wish to test a material for its resistance to the specific character of fatigue failure experienced in a tire, we should duplicate the conditions in the tire. We cannot hope to do this with any instrument except a tire. This makes it imperative that we augment any fatigue test results by interpreting them in the light of all the other facts which we know about the yarn and the cord and their service in a tire.

The Goodyear tester,[3] probably most nearly simulates the conditions met in a tire. The sample for this test is made up by wrapping a group of test cords around a rubber hose so the cords are parallel to the axis of the hose, then covering with thin rubber, wrapping this with a single cord wound spirally on the outside, covering this with a thin sheet of rubber, and curing in a mold. The sample is mounted on the ends of two spindles, *A* and *B*, and rotated about its curved axis as shown in Fig. 1. As a cord passes *C* it is stretched, and as it passes *D* it is shortened. Mr. Mallory believes the failure of a cord arises, at least partly, from the fact that it is a spiral, and when shortened it tries to expand laterally, but, being encased tightly in the rubber under the lateral pressure of inflation, it is prevented from doing this, and so is subjected to violent longitudinal forces which tend to make it buckle and crumple like a column. Since a low-twist spiral must expand more on being shortened than a high-twist spiral, the compression stresses are accentuated, and we get a quicker failure with low-twist cords. Low twist, of course, is relative, and what is low twist for one product may be normal for another and high for still another. Dr. Swanson, of our Nylon Research Section, made an interesting analysis of this relationship of twist to the lateral expansion of a cord when it is shortened. Figure 2 shows how much more the diameter of a low-twist cord increases when the cord is shortened 10 per cent than does the diameter of a high-twist cord. This indicates a fatigue sensitivity to twist which many fatigue testers do not show, but which is very evident in tires.

Although this tester gives most satisfactory results when properly run, it should not be recommended to the rayon industry due to the large amount of the tiremaker's skill and equipment required for its satisfactory use.

The Firestone Snap-cycle Stitched-block tester[4] I would eliminate because it reverses the relationship of twist to fatigue shown in a tire. It is true that our interest is in testing rayon and not in determining the optimum twist for cords. Some may go still further and say we are not interested in cords and should test yarn. I do not agree with that viewpoint; I think we, as rayon manufacturers, are deeply

[3] Discussed by Mr. Mallory at the July, 1943, and October, 1943, meetings of Committee D-13.

[4] Described at the July, 1943, meeting of Committee D-13.

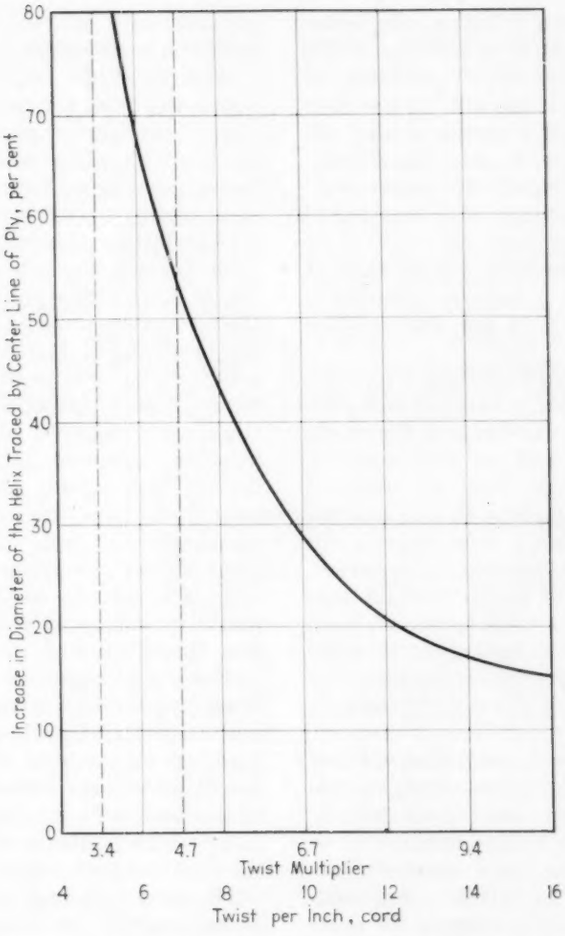

Fig. 2.—Percentage Increase in Diameter *versus* Cord Twist for 210 by 3/3 Nylon Cord when Shortened 10 per cent.

concerned with cords. When the yarn fails, it is in a cord; the stresses which cause its failure are all wrapped up with the twisted structure of the cord and how that structure acts when in the tire. If a tester reverses the order of a twist series shown by a tire, it seems obvious it is not giving the emphasis which is given by the tire to those stresses and strains which are present due to the twisted cord structure.

The Goodrich tester is a simple little machine easy to operate and easy to maintain. Most of you have read the very interesting discussion of its operation printed in the *Journal of Applied Physics*, November, 1942, and many of you have used the machine extensively.

The parameters of this tester are:

Stroke	0.032 in. = 0.43 per cent of sample's length
Sample length	7.5 in.
Cycles	3600 per min.
Temperature	350 F.
Load	5 lb.

The high frequency is used to avoid the resonance effect and the very large forces which quickly destroy the cords when the frequency approaches the natural frequency of the weighted cord. This high frequency combined with the mechanical design of the machine necessitates the short stroke. Using this short stroke, it is necessary to operate at a very high temperature in order to reduce the time required for a test to an acceptable figure. At the temperature of 350 F. which is required to accomplish this, the rayon ages about as much as it is fatigued. A rayon cord which required 10 hr. fatigue under these standard conditions lost 27 per cent of its strength when aged under the same conditions of time, temperature, and moisture. I would eliminate this tester on the basis that it is to too great a degree a heat aging tester, and that in a twist series it reverses the order shown by a tire test.

Because of its simplicity, practically everybody has at one time or another experimented with a "pulley"-type tester in which the cord is caused to flex around a small diameter pulley while it is under a given load. It is interesting to note how most of the large rubber companies went through the same cycle of experimenting with this type of tester, using it for a period and then abandoning it. We must not conclude from this, however, that a satisfactory pulley tester cannot be made. Certainly the one recently developed by Rayonier is interesting and should be followed up. I know of no pulley tester which has been satisfactorily correlated with tire tests.

The U. S. Rubber tester is the only remaining cord tester for which there is a long background of correlation with tire tests. This tester has some definite faults, but when handled carefully and interpreted intelligently, it is a great help.

Figure 3 is a schematic end view of this machine. The shaft *A* is provided with six double-ended rocker arms *B*, and is caused to operate by the single eccentric *LM*. The machine is provided with an adjustment by which the length of the stroke can be controlled.

The sample *E*, fastened between the jaws *C* and *D*, consists of 20

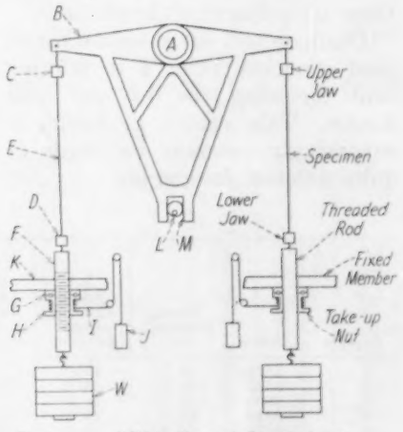

Fig. 3.—U.S. Rubber Co. Fatigue Tester Schematic End View.

ends of cord 30 in. long between the jaws. In preparing the specimen, the cord is conditioned and then strung up on a jig in which each cord is weighted with a standard weight, the ends cemented to protect them against the jaws, and the jaws clamped in place. The jig is then placed in the conditioning oven provided with the same atmosphere as that used in the tester. The lower jaw *D* is fastened to the threaded rod *F*, which passes through the fixed plate *K*, and is provided with a hook at its lower end for the weights *W*. The ball bearing takeup nut *G* is provided with a drum *H*, around which is wound the cord *I*, which in turn is weighted by *J*.

In this tester, the weight *W* in general corresponds to the inflation load on the cord. In the operation of a tire, the cyclical forces which cause the cord to stretch are independent of the inflation load. Yet that portion of the elongation produced by these stresses which is not recovered before the next cycle takes place is taken up by the inflation pressure. The purpose of the nut *G* is to simulate this action. With each downward stroke of *B*, that portion of the elongation produced by the upward stroke of *B* which is not recovered during the downward stroke is taken up. This, of course, varies with the rapidity of the cycles and with the length of the stroke. For this reason, the machine is very sensitive to variations in the length of the stroke.

During a test our standard rayon cord stretches from 6 to 6.5 per cent including the 1.6 per cent stroke. This stretch at failure is surprisingly constant for cords of quite different fatigue life.

As mentioned before, the tester is quite sensitive to a change in the length of the stroke. A change of 0.003 in. will cause a 15 per cent change in the fatigue hours obtained. This means the stroke must be measured at frequent intervals and corrected if it has altered through wear.

The temperature is maintained at 49.5 ± 10 C., and the humidity is kept at 11 ± 1 per cent relative humidity.

There is a difference in stroke between the center and the end position due to the twist of the shaft. This causes a 25 per cent variation between single tests on different spindles. It is expected that a new design which is now in progress will correct this trouble. To correct this variation in the present machine, we test three specimens from each cord, distributing the three on one of four groups of spindles, thus —1, 5, 9; 2, 6, 10; 3, 7, 11; or 4, 8, 12.

When we run unknowns, we test three specimens from each sample and place them on the machine in that order. If the maintenance of the machine has been properly attended to, it will give less than ±10 per cent variation in the average of one group of three from the average of any other group of three, when grouped as stated above. If a carefully prepared cord of selected yarn is tested on all twelve positions, no single position will vary more than ±30 per cent from the average of the twelve. The average deviation of single cords from the average of the twelve will range between 11 and 15 per cent.

When checking plant production we obtain several samples per day but run only one specimen of 20 ends from each sample.

Some time ago, Dr. Venable prepared cord from a series of yarns of widely varying properties for the purpose of making fatigue studies. He very kindly provided samples of these cords to be tested on the various fatigue testers available.[5]

In Table I, opposite the properties of these cords, we have shown the test values observed on a U. S. Rubber Fatigue Tester and in the next column our corrected values. Some of these corrections are quite large; for example, although the machine registered 21 for sample No. 9, our figure, corrected for elongation, says the cord is quite unsuitable for tires. This instrument is overly sensitive to changes in yarn elongation so the observed results must be corrected for elongation based on our knowledge of how the yarn and cord were made. Until we have enough basic information to test fatigue as a specific fundamental property of our cellulose filaments, we must interpret our fatigue results in the light of everything we know about the yarn and the cord and their use in a tire.

The proper elongation for a cord is determined by the tiremaker from his experience in building tires. In testing the fatigue of our rayon, we are not attempting to determine the best cord elongation to use in a tire. That can be done only by testing tires. We should select a standard cord construction for use in our fatigue tests and if we wish to test a high elongation yarn we should first slash it until it will give a standard 10-lb. load elonga-

[5] See paper by C. S. Venable on "Comparative Fatigue Test Data," p. 17 for a presentation of the results of tests on various cords.

TABLE I.

Sample	Denier	Break Strength, lb.	Break Elongation, per cent	10-lb. Load Elongation, per cent	Tenacity, 70F.—60% R. H., g. per denier	Oven Dry Tenacity, g. per denier	Oven Dry Strength, lb.	Oven Dry Break Elongation, per cent	Oven Dry 10-lb. Load Elongation, per cent	Singles Twist, turns per in.	Cord Twist, turns per in.	Observed Fatigue, hr.	Fatigue Corrected to 10 per cent, 10-lb. Load Elongation, hr.[a]
1....	2472	13.7	13.9	9.9	2.51	2.99	16.3	10.8	5.4	17.3	12.2	16.8	17.1
2....	2597	14.0	14.3	13.3	2.45	2.95	16.9	13.9	5.8	17.8	12.3	46.3	35.8
3....	2564	12.5	12.8	10.3	2.21	2.83	16.0	9.8	4.5	17.7	12.0	2.8	2.0
4....	2545	11.6	13.1	11.5	2.07	2.71	15.2	9.7	3.8	17.6	11.9	1.08	0
5....	2534	14.5	15.4	10.5	2.60	2.95	16.5	10.4	5.0	17.7	12.1	24.50	23
6....	2541	14.0	15.1	10.5	2.50	2.71	15.2	9.8	4.8	18.0	12.2	27.42	25.8
7....	2581	13.9	15.4	10.6	2.44	2.97	16.9	11.2	4.7	17.7	12.1	17.3	15.3
8....	2340	12.7	9.6	7.5	2.46	2.98	15.4	8.0	4.5	17.6	12.4	6.7	14.7
9....	2650	13.8	22.6	16.5	2.36	2.91	17.0	15.9	6.0	17.5	12.2	21.0	0
10....	2583	11.6	13.9	11.9	2.04	2.37	13.5	9.4	6.0	17.7	12.6	5.3	0
11....	2509	13.8	13.6	9.8	2.49	2.93	16.2	8.6	3.9	17.4	12.4	17.0	17.6
12....	2526	14.2	12.7	9.0	2.55	2.87	16.0	8.0	3.5	17.4	12.3	9.0	12.2
13....	2582	14.8	14.5	9.6	2.60	2.97	16.9	9.7	4.1	17.7	12.3	30.3	31.5
14....	2600	14.2	15.8	11.1	2.48	2.95	16.9	10.2	4.2	17.7	12.2	15.9	12.4

[a] Correction of observed fatigue hours based on 3.2 hr. per 1 per cent variation in elongation from 10 per cent at 10-lb load.

tion when twisted into the selected standard cord. Then our fatigue test will reflect its relative value.

When we use a fatigue tester as a plant control, the elongations of the tested cords will not vary greatly from our standard. If they do, we will know what operations in our plant have caused them to vary. If we do not know, we, of course, will immediately attempt to find out and can interpret the fatigue tests in the light of what it is we learn. Thus in the main we are concerned with testing cords with a constant elongation. When that is true the results of the U. S. Rubber tester can be taken at their face value—at least for all the conditions we have studied.

Though we have made many fatigue tests on cords made from wood pulp rayon, we do not have adequate tire tests to tell us how the machine results correlate with the tire tests. I understand that in at least one case they did not correlate. The tester gave a high value and the tire a low value.

During the past several years we have guided our "Cordura" research by the results obtained from a U. S. Rubber-type fatigue tester. While not perfect, it is an excellent instrument and if carefully interpreted will serve the industry well. In conclusion, I wish again to state that I urgently suggest you do not at this time recommend any fatigue tester as a standard.

Comparative Fatigue Test Data*

By C. S. Venable[1]

In connection with the study on fatigue testers for tire cord being made by W. H. Bradshaw, for Section IV on Tire Fabrics of Subcommittee A-1 of A.S.T.M. Committee D-13 on Textiles,[2] it was thought advisable to have sample cords covering a fair range of yarn toughness tested by companies using various types of machines and testing procedures. It was hoped that a correlation of the data so obtained might assist in pointing the way toward the selection of a standard machine, or toward the development of a machine that might properly serve as a "standard."

Fourteen cords were accordingly prepared from yarn produced in the Experimental Department at Marcus Hook (American Viscose Corp.) and were distributed to nine companies. Such data as were available were reported at the meeting of Subcommittee A-1 in New York on March 9, 1944. Additional data have been received since that time, and the completed report is given herewith.

Cord Samples

All cords were two-ply (17 Z – 12 S) construction—all yarns carried the same finish.

No. 1—Pulp base = 70 per cent cotton, 30 per cent wood; NaOH in viscose = 8 per cent and salt test = 5.2; $ZnSO_4$ = 5 per cent; CS_2 = 35 per cent. Slashing stretch = 6½ per cent.

No. 2—Same as No. 1. Slashing stretch = 3 per cent.

No. 3—All wood pulp base. Spinning conditions were all unfavorable.

No. 4—100 per cent cotton pulp base. CS_2 = 40 per cent; salt test = 2.0.

No. 5—Same as No. 4. Salt test = 5.2.

No. 6—Same as No. 4. Salt test = 6.1.

No. 7—Same as No. 5. $ZnSO_4$ = 1 per cent.

No. 8—Same as No. 1. Slashing stretch = 12 per cent.

No. 9—Same as No. 1. Slashing stretch = 0 per cent.

No. 10—Same as No. 5. NaOH in viscose = 6.6 per cent.

No. 11—Same as No. 1. Special wood pulp base.

No. 12—Same as No. 1. Regular wood pulp base.

No. 13—Same as No. 5. CS_2 = 35 per cent.

No. 14—Same as No. 5. CS_2 = 30 per cent.

TABLE I.—PERCENTAGE OF AVERAGE READINGS.

Sample	Goodyear Tube	A. V. C.,[a] Firestone Old Type	A. V. C.,[a] Brosam	du Pont, U. S. Rubber Type	U. S. Rubber, Detroit	Goodrich, Akron	A. V. C.,[a] Goodrich Type	Riordan, Goodrich Type	Firestone, New Type	A. D. Little, Abrasion	North American	A. D. Little, M. I. T. Folding	Riordan, Schopper Folding	Riordan, Bending
No. 1	93	122	90	114	127	108	112	107	117	107	107	61	96	136
No. 2	107	177	174	246	224	118	145	144	109	123	140	136	114	125
No. 3	51	48	38	13	31	72	82	46	56	67	74	58	68	64
No. 4	58	28	24	0	22	74	60	30	53	76	56	31	50	52
No. 5	111	120	165	153	112	113	109	118	112	89	119	147	123	129
No. 6	115	79	148	172	117	102	98	122	67	72	109	122	152	127
No. 7	98	120	108	102	64	101	101	102	123	117	105	148	155	79
No. 8	66	80	46	98	...	97	99	84	60	75	92	37	34	55
No. 9	119	122	160	0	...	116	105	139	26	248	125	95	76	120
No. 10	105	10	28	0	...	68	71	33	39	32	44	47	49	73
No. 11	106	135	74	117	...	102	92	102	106	98	115	83	114	77
No. 12	126	57	70	81	...	105	98	75	129	75	83	86	77	98
No. 13	125	139	165	210	...	116	131	174	197	101	120	203	179	114
No. 14	119	165	118	83	...	117	105	122	188	110	108	148	102	84
Avg. Reading = 100	646 000	26 000	50	15.0	180	88	11.0	626	296	2700	196	64	1199	257

[a] American Viscose Corp.

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* Originally presented at the March, 1944, meeting of Committee D-13 on Textile Materials, revised as of August 11, 1944.

[1] Director, Chemical Research Dept., American Viscose Corp., Marcus Hook, Pa.

[2] See p. 13.

TABLE II.

Variable	Variation	Sample	Goodyear Tube	A. V. C., Firestone Old Type	A. V. C., Brosam	du Pont, U. S. Rubber Type	U. S. Rubber	Goodrich, Akron	A. V. C., Goodrich Type	Riordan, Goodrich Type	Firestone, New Type	A. D. Little, Abrasion	North American	A. D. Little, M. I. T. Folding	Riordan, Schopper Folding	Riordan, Bending
Effect of slashing	3 per cent	No. 2	107	177	174	246	224	118	145	144	109	123	140	136	114	125
	0 per cent	No. 9	119	122	160	0	...	116	105	139	26	248	125	95	76	120
	6 per cent	No. 1	93	122	90	114	127	108	112	107	115	107	107	61	96	136
	12 per cent	No. 8	66	80	46	98	...	97	99	84	60	75	92	37	34	55
Effect of pulp	100 c	No. 5	111	120	165	153	112	113	109	118	112	89	119	147	123	129
	70 c–30 w	No. 1	93	122	90	114	127	108	112	107	117	107	107	61	96	136
	Rayocord	No. 11	106	135	74	117	...	102	92	102	106	98	115	83	114	77
	100 w	No. 12	126	57	70	81	...	105	98	75	129	75	83	86	77	98
Effect of viscose age	5.2 S. T.	No. 5	111	120	165	153	112	113	109	118	112	89	119	147	123	129
	6.1 S. T.	No. 6	115	79	148	172	117	102	98	122	67	72	109	122	152	127
	2.0 S. T.	No. 4	58	28	24	0	22	74	60	30	53	76	56	31	50	52
Effect of CS_2	40 per cent	No. 5	111	120	165	153	112	113	109	118	112	89	119	147	123	129
	35 per cent	No. 13	125	139	165	210	...	116	131	174	197	101	120	203	179	114
	30 per cent	No. 14	119	165	118	83	...	117	105	122	188	110	108	148	102	84
Effect of $ZnSO_4$	5 per cent	No. 5	111	120	165	153	112	113	109	118	112	89	119	147	123	129
	1 per cent	No. 7	98	120	108	102	64	101	101	107	115	117	105	148	155	79
Effect of NaOH	8 per cent	No. 5	111	120	165	153	112	113	109	118	112	89	119	147	123	129
	6.6 per cent	No. 10	105	10	28	0	...	68	71	33	39	32	44	47	49	73
Good *versus* bad	...	No. 5	111	120	165	153	112	113	109	118	112	89	119	147	123	129
	...	No. 3	51	48	38	13	31	72	82	46	56	67	74	58	68	64

TABLE III.

	Sample	Goodyear Tube	A. V. C., Firestone Old Type	A. V. C., Brosam	du Pont, U. S. Rubber Type	U. S. Rubber, Detroit	Goodrich, Akron	A. V. C., Goodrich Type	Riordan, Goodrich Type	Firestone, New Type	A. D. Little, Abrasion	North American	A. D. Little, M. I. T. Folding	Riordan, Schopper Folding	Riordan, Bending
ABOVE AVERAGE	No. 1	X	√	X	√	√	√	√	√	√	√	√	X	X	√
	No. 2	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	No. 5	√	X	√	X	√	√	X	√	√	X	√	X	X	√
	No. 6	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	No. 9	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	No. 11	√	√	√	√	√	√	√	√	X	√	√	√	√	√
	No. 13	√	√	√	X	√	√	√	√	√	X	√	X	X	√
	No. 14	√	√	√	√	√	√	√	√	√	√	√	√	√	√
BELOW AVERAGE	No. 3	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	No. 4	√	√	X	√	√	X	X	√	X	√	X	X	X	√
	No. 7	√	√	√	X	√	√	√	√	√	√	√	√	√	√
	No. 8	X	√	√	√	√	√	√	√	√	√	√	√	√	√
	No. 10	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	No. 11	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	No. 12	X	√	√	√	√	X	√	√	√	√	√	√	√	√
	Misses (Reversing No. 7)	4	1	1	2	..	1	2	0	2	2	0	2	2	2

Test Data

The data in Table I are arranged in order of sample number. For any one set of cord tests, the average reading was given the rating of 100, and each cord was then rated as percentage of this average. For example, the average Goodyear tube reading on the 14 cords, 646,000 cycles, was rated 100. Sample No. 1, with a reading of 600,000 cycles was rated 93 per cent.

In Table II the values given in Table I have been rearranged according to variation in yarn production conditions. Under "Sample" is the decreasing order of cord fatigue that would be expected from the experience of the rayon manufacturer. For example, in the second bracket "Effect of Pulp," sample No. 5, a 100 per cent cotton linter rayon would be expected to produce cords of a higher resistance to fatigue than sample No. 1, which was made from a pulp base of 70 per cent cotton and 30 per cent wood, all other rayon manufacturing conditions being similar or equivalent. Still lower readings would be expected for sample No. 11, and still lower for sample No. 12.

In Table III the values given in Table I were regrouped into "Above Average" and "Below Average." The *expectancy* is indicated by the sequence shown. Agreement between *found* and *expectancy* is indicated by check mark, contrariwise by a cross mark. For example, Goodyear rated sample No. 9 at 119 per cent of the average, and above average was expected. Goodyear rated sample No. 10 at 105 per cent and a below average reading was expected (and was obtained in all the other tests).

The *expectancy* in the case of

TABLE IV.—CORD TENSILE STRENGTHS.

Sample	Corrected Denier	Corrected Cord Tenacity, g. per denier	Corrected 10-lb. Elongation, per cent	Oven Dry Tenacity, g. per denier	Oven Dry Elongation at Break, per cent
No. 1	2472	2.51	9.9	2.99	10.8
No. 2	2597	2.45	13.3	2.95	13.9
No. 3	2564	2.21	10.3	2.83	9.8
No. 4	2545	2.07	11.5	2.71	9.7
No. 5	2534	2.60	10.5	2.95	10.4
No. 6	2541	2.50	10.5	2.71	9.8
No. 7	2581	2.44	10.6	2.97	11.2
No. 8	2340	2.46	7.5	2.98	8.0
No. 9	2650	2.36	16.5	2.91	15.9
No. 10	2583	2.04	11.9	2.37	9.4
No. 11	2509	2.49	9.8	2.93	8.6
No. 12	2526	2.55	9.0	2.87	8.0
No. 13	2582	2.60	9.6	2.97	9.7
No. 14	2600	2.48	11.1	2.95	10.2

sample No. 11 was doubtful, and, accordingly, this sample was listed in both groups, and the check marks simply indicate where found (8 above average, 5 below average).

The case of sample No. 7 shows a bad score for *expectancy* (3 to 11), and accordingly was counted in reverse in the tally of "misses" given in the last line; that is, a check mark for sample No. 7 was counted as a miss, and a cross mark as a hit.

The cord tensile strengths as given in Table IV were taken from data submitted by the du Pont Rayon Co.

Discussion of Data

It is noted that the testing machines used to evaluate these cords covered a wide variety. Three sets of data were obtained with vibration type machines (Goodrich) operating at relatively high temperatures, three sets with machines of the folding type (Schopper), two sets with the intermittent stretching multiple strand type (U. S. Rubber), one set with a strictly yarn-to-yarn abrasion type machine, one set of the compression-relaxation type (Goodyear tube), and one set each of various other types. Nevertheless, there was a good general agreement with all the machines on a majority of the cords tested, for example, samples Nos. 2, 3, 4, 5, 8, 10, 13, 14 in Table III. This suggests a common denominator for all these varied types of "fatigue" tests. This might be the *toughness* of the yarn, as distinguished from mere breaking strength, the yarn's ability to "take it."

When the attempt was made to distinguish between relatively small variations in yarn quality (Table II), the general lack of agreement with the "expected" would indicate that none of the fatigue tests has a sensitivity or a reliability that is sufficient for that purpose.

In general, it can be concluded that all of the machines are capable of giving an approximate evaluation, can differentiate good from bad, but that none is sufficiently reliable to be accepted as a standard. Since yarn toughness is probably the fundamental factor involved, any standard fatigue testing procedure that is developed for evaluating rayon for tire purposes should emphasize this quality. It can be relatively simple, and need not necessarily attempt to parallel every service condition in a tire.

Statistical Comparison of Rayon Tire Cord Fatigue Testing Machines*

By C. B. Budd[1] and L. Larrick[2]

During 1943 there were several meetings of representatives of the tire manufacturers, among themselves, and with representatives of the suppliers of high tenacity rayon, to discuss fatigue testing machines for rayon tire cord. The bare cord testers in use by tire manufacturers were described, ratings and comparison with tire tests being given for the five suppliers. In addition, some of the machines in use by rayon manufacturers were described.

Only one tire company had found it possible to rely on its fatigue machine to the extent of actually accepting or rejecting yarn for production on the basis of fatigue tests. Therefore, the special committee appointed by Section IV, Subcommittee A-1, decided to sponsor a direct-inter-comparison of the machines.

Fourteen 1100/2 cords in identical twists were prepared by the Experimental Department of the American Viscose Co. and distributed to nine companies for tests. Apparently the differences between the yarns of these cords run the gamut of what is known to be good and bad in high tenacity yarn manufacture.

The results are summarized in Venable's report of August 11, 1944.[3] As noted in that report there is good general agreement among the machines on a majority of the cords. This high level of agreement suggested to the authors that the fatigue machines must have some causal elements in common and that a statistical analysis of the data might indicate their nature.

The data to be analyzed are those summarized in Venable's Table I, with two exceptions. Instead of the results from U. S. Rubber-Detroit, which are incomplete, we have included data obtained on the new, commercial model of the B. F. Goodrich Tension Vibrator. Arbitrary numbers are assigned to the testing machines, hereafter referred to as testers, as listed in the accompanying Table I, in order to simplify handling the data.

The first step in the study was to plot the scatter diagrams of the fatigue results taking the 14 testers two at a time. It is impossible to

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* Presented at the October, 1944, meeting of Committee D-13 on Textile Materials.

[1] Research Dept., The B. F. Goodrich Co., Akron, Ohio.

[2] Formerly with Research Dept., The B. F. Goodrich Co., Akron, Ohio, now with Inst. of Textile Technology, Charlottesville, Va.

[3] See p. 17.

TABLE I.—FATIGUE TESTERS STUDIED.

Tester Number	Identification
1.....	B. F. Goodrich, Tension Vibrator
2.....	Goodyear Tube
3.....	A. V. C.[a] Firestone, Old Type
4.....	A. V. C.,[a] Brosam
5.....	du Pont, U. S. Rubber Type
6.....	Goodrich, Akron
7.....	A. V. C.,[a] Goodrich Type
8.....	Riordan, Goodrich Type
9.....	Firestone, New Type
10.....	A. D. Little, Abrasion
11.....	North American
12.....	A. D. Little, M. I. T. Folding
13.....	Riordan, Schopper Folding
14.....	Riordan, Bending

[a] American Viscose Corp.

reproduce all diagrams but it is believed the examples given in Figs. 1 and 2 will adequately illustrate the correlations obtained.

In general, the diagrams show rough correlation, high values on the one test accompanying high values on the other. Figure 1 shows two examples of fair correlation, one example of very poor correlation, and one case of good but nonlinear correlation. Since this was the only one of the 91 diagrams showing definite nonlinear relationship, the analysis will be made on the basis of linear correlations.

The diagrams of Fig. 2 illustrate the common-sense reasonableness of the simple correlation coefficient, that the coefficient is a quantitative measure of what one can see in the scatter diagrams. For instance, one should expect high correlation between the new improved B. F. Goodrich Tension Vibrator and the older laboratory machines. The scatter diagram and the value of the coefficient ($r = 0.94$) confirms this. Likewise, two vibrator type testers such as Goodrich-Akron and A.V.C.-Goodrich can be expected to give high correlation since they are similar machines: $r = 0.74$.

In the same way the two folding testers should have good correlation ($r = 0.87$) if they are as described. And it is reasonable to assume that, as in the last illustration of Fig. 2, a folding test would have some elements in common with a bend test ($r = 0.50$).

Although all the diagrams cannot be shown, we have constructed a chart (Fig. 3) showing the correlation coefficients between machines. The ordinates are tester numbers (identified in Table I), the abscissae are the values of r. Starting at tester No. 10, say, and going across the chart we find tester No. 13 at a value of r between 0 and 0.1—that is, the correlation between testers Nos. 10 and 13 ($r = 0$) is very poor.

One can see that, in general, the correlation coefficients are above 0.50. The chief exception seems to be No. 10, the Abrasion Tester, which shows the poorest correlation with the others. Tester No. 9, Firestone new type, shows the next lowest correlation and it may be significant that these two have quite a bit in common, in an inverse way ($r = -0.37$).

The correlation of tester No. 1, the new B. F. Goodrich Tension Vibrator, with all the others (even with No. 10) is outstandingly high, the average being $r = 0.75$. In order to show this high level more clearly we have marked on the chart with 0 the value of the coefficient between No. 1 and each of the other thirteen testers.

Having seen a fair level of agreement among the machines in the tabulated data of Venable's report and in our scatter diagrams, and having the statistical analysis confirm what we could see, we were curious to seek the common causes.

Venable's report gives certain of the physical properties of the 14

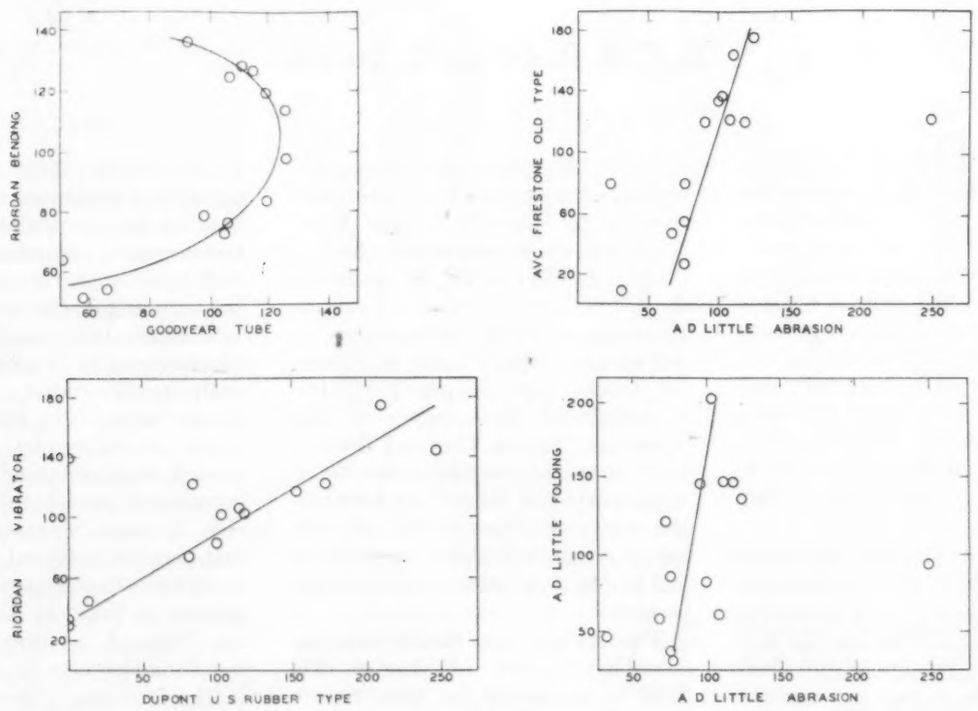

Fig. 1.—Representative Scatter Diagrams—Comparison of Fatigue Testers. (These Testers Do Not Have Obvious Elements in Common.)

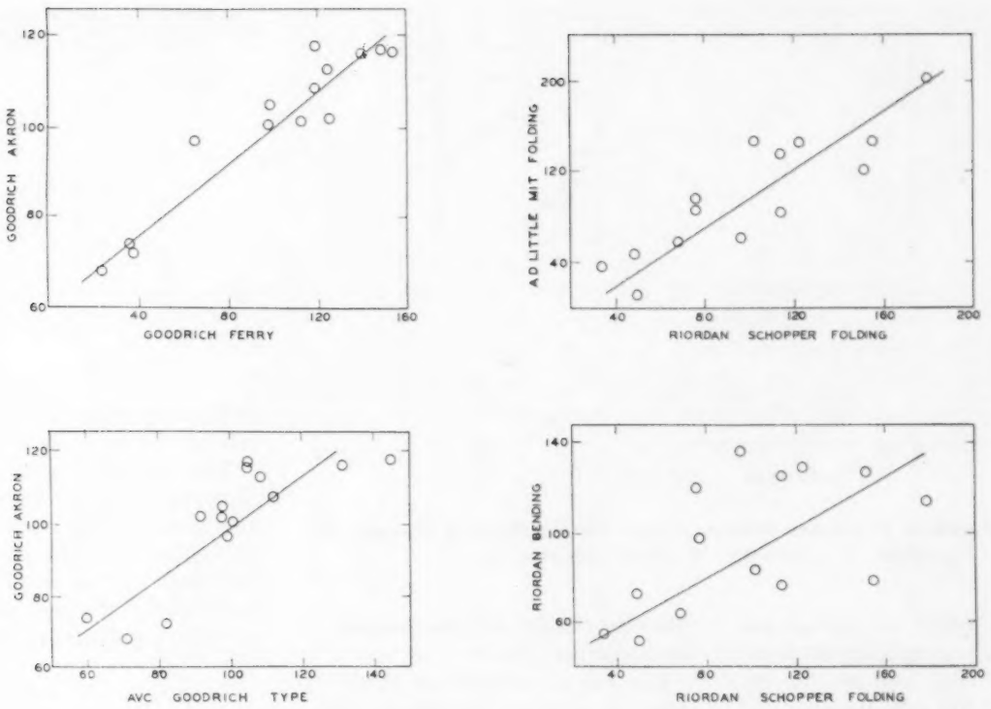

Fig. 2.—Scatter Diagrams for Testers Which Have Obvious Elements in Common.

cords. The simple correlation coefficients between each of the fatigue testers and each of the properties listed below were computed:

Number	Identification
20	Oven dry breaking strength
21	Oven dry elongation at break
22	Oven dry tenacity
23	Break constant (20 by 21)

The properties used were either taken from Venable's report or computed from those given therein. These coefficients are shown in Fig. 4, using the same scheme as in Fig.3.

The two folding testers (Nos. 12 and 13) and the Goodyear tube do not depend, to any great extent, on any of these factors, nor does the bend tester (No. 14). Surprisingly, the abrasion tester (No. 10) has a lot of respect for elongation (r = 0.88) and the new Firestone (No. 9) practically none for elongation or the break constant. The U. S. Rubber data (No. 5) have been carefully corrected for elongation. The vibrator type testers (Nos. 1, 6, and 7) are dependent upon breaking strength, or tenacity, but relatively independent of elongation.

In computing these coefficients we have ignored the fact that breaking strength and elongation are not independent of each other—we know, for instance, that an abnormally low break is invariably accompanied by an abnormally low elongation. There is an analogous situation in partial differential equations where one has to be careful to differentiate with respect to a variable *explicitly* and *implicitly*. So far, one might say we have differentiated with respect to breaking strength and elongation only explicitly. Can we consider the effect of breaking strength alone, independ-

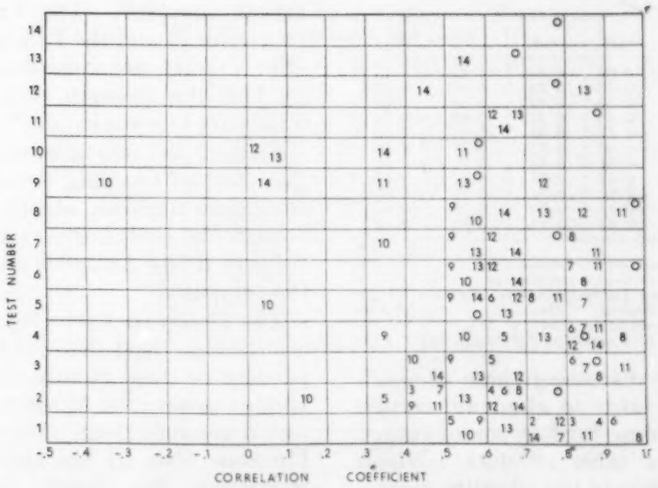

Fig. 3.—Coefficient of Correlation Between Fatigue Testers.

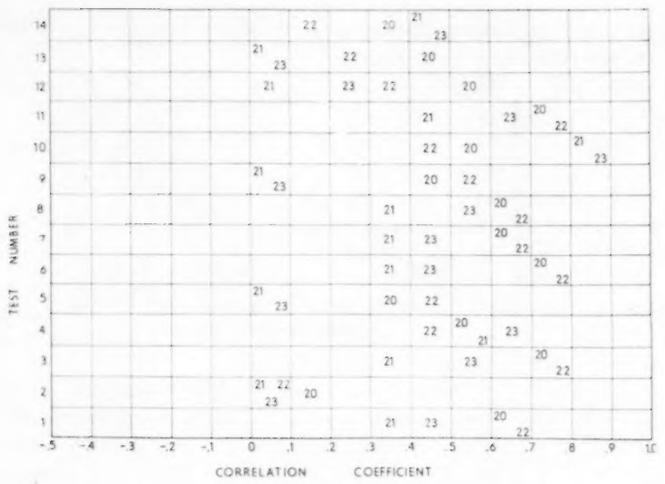

Fig. 4.—Coefficient of Correlation Between Fatigue Life and Breaking Strength (20), Elongation (21), Tenacity (22), Break Constant (23).

ently of the effect of elongation upon breaking strength, by statistical analysis? Yes, and we can go even further. We can consider the effect of both together, regardless of the way they act. These comparisons are made by means of the appropriate partial correlation coefficients. The results of the computations are given in Table II.

TABLE II.—CORRELATION BETWEEN TESTERS AND BREAKING STRENGTH AND ELONGATION.

Tester Number	r_{xz}[a]	r_{xz}[b]	$\bar{R}$[c]	CR[d]
1....	0.09	0.66	0.82	0.01
2....	0.10	0.24	0.00	0.21
3....	0.19	0.73	0.89	0.01
4....	0.46	0.51	0.68	0.01
5....	−0.17	0.43	0.44	0.06
9....	−0.58	0.71	0.77	0.01
10....	0.81	0.53	0.70	0.01
11....	0.32	0.71	0.87	0.01
12....	−0.02	0.57	0.70	0.01
13....	−0.12	0.50	0.58	0.02
14....	0.38	0.24	0.03	0.13

[a] Not corrected for sample size.
[b] Not corrected for sample size.
[c] Corrected for sample size, formula 47, in Mordecai Ezekiel, "Methods of Correlation Analysis," second ed., 1941, p. 211.
[d] Based on formula 74.05, *Ibid.*, p. 323.

Before discussing these comparisons we wish to eliminate certain testers from further consideration. Venable's table of data includes three testers of the vibration type—Nos. 6, 7, and 8. We delete the results under No. 6 (Goodrich-Akron) because these machines are obsolete and have been replaced by No. 1 (The B. F. Goodrich Tension Vibrator). The vibrator at the Front Royal Plant of the A. V. C., No. 7, is eliminated for the same reason and because the results show poor correlation with testers No. 1 and No. 6. We also eliminate No. 8 (Riordan Goodrich Type) because of the higher amplitude.

The second column of Table II gives the effect of elongation, holding breaking strength constant. None of the testers, except Nos. 9 and 10, depend to any great extent on elongation. These computations indicate that No. 5 (U. S. Rubber Type) has been over-corrected.

The third column gives the effect of breaking strength alone, elongation constant. The Goodyear tube (No. 2) and the Riordan bend (No. 14) are not influenced much by breaking strength, but all the others are to some extent.

Finally, the fourth column gives the effect of breaking strength and elongation together, and in the last column the probability of a chance value of $\bar{R}$ (see Table II) as large as the computed.

The Goodyear tube (No. 2) and the Riordan Bend (No. 14) are independent of these factors, the U. S. Rubber tester (No. 5) has been corrected to some extent. The old type Firestone (No. 3) has the highest correlation, the North American (No. 11) the next, B. F. Goodrich machine (No. 1) rather high, and the others somewhat lower.

The regression formulas of fatigue life in terms of breaking strength and elongation, Table III, give an estimate of the relative importance each tester attaches to these factors. These formulas cannot be taken very seriously without actual check because it is known

TABLE III.—REGRESSION FORMULAS FOR FATIGUE IN TERMS OF BREAKING STRENGTH AND ELONGATION.

Tester Number	Formula[a]
1.....	$28.1\,T + 1.41\,E - 366$
2.....	$6.14\,T + 1.21\,E - 11$
3.....	$32.9\,T + 3.19\,E - 461$
4.....	$23.7\,T + 1.03\,E - 291$
5.....	$35.9\,T - 6.31\,E - 412$
8.....	$24.6\,T + 3.78\,E - 335$
9.....	$38.7\,T - 13.2\,E - 386$
10.....	$15.1\,T + 16.0\,E - 309$
11.....	$17.2\,T + 2.83\,E - 206$
12.....	$30.4\,T + 0.51\,E - 393$
13.....	$22.8\,T - 2.26\,E - 244$
14.....	$6.61\,T + 5.34\,E - 66$

[a] E = Per cent ultimate elongation at rupture, oven-dry. T = Oven-dry breaking strength, pounds.

that many of the values of the correlation ($\bar{R}$ in Table II) were low.

The scatter diagrams, which are illustrated in Figs. 5 and 6, serve as the check on the goodness of fit of the equations. In these diagrams we plot the value of fatigue life computed from the appropriate regression equation against the actual life.

In general the predictive formulas are not very helpful. On the abrasion tester and on the North American the equations do fairly well. With the new Firestone tester the scatter is bad. If one were using the Goodyear tube he would throw away the formula—it was stated before that tube results are independent of breaking strength and elongation. On the older Goodrich vibrator the predictions would be fair because the data are clustered. The new model is much more sensitive and the formula would not be of much value. The Riordan folding tester shows nonlinear correspondence—second order corrections or curvilinear correlation are indicated. The bend test also indicates poor prediction and need for further statistical corrections.

We have reached a point where we may recapitulate:

We find a fair level of agreement among these 14 diverse testers—some vibrate the cord in tension, some jerk it in tension or through a block of special rubber, some bend it over a pulley, some fold it, and one just abrades it. We find that breaking strength and elongation account for many of the elements of the fatigue test in most cases, but account for none of the results in some.

Although we have found correlations which might be satisfactory in some economic or biological sur-

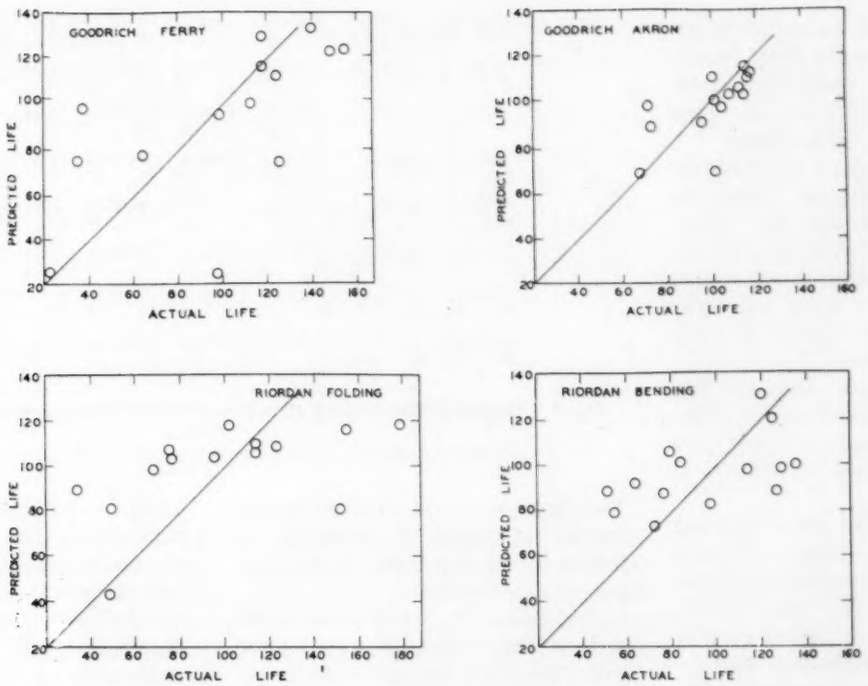

Fig. 5.—Scatter Diagrams of Predicted Life *versus* Observed Life. (Prediction Based on Breaking Strength and Elongation.)

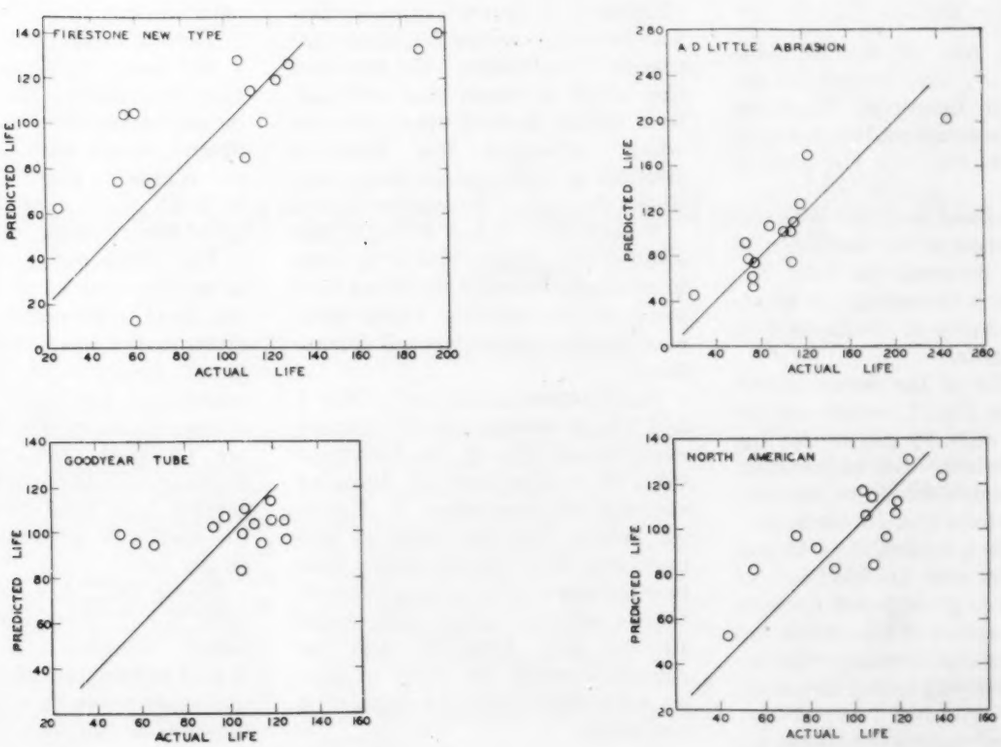

Fig. 6.—Scatter Diagrams of Predicted Life *versus* Observed Life.

1-52	-2	1-69	-3	1-72	-3	1-33	-5	1-35	-9	1-27-10		1-75-11		
67	0	67	79	67	47	67	19	67	59	67	49	67	76	
1-57-12		1-45-13		1-49-14		2-17	-3	2-41	-4	2-13	-5	2-18	-9	
67	50	67	33	67	7	0	79	0	47	0	19	0	59	
2	-3-10	2-20-11		2-41-12		2-26-13		2-37-14		3-54	-4	3-39	-5	
0	49	0	76	0	50	0	33	0	7	79	47	79	19	
3-33	-9	3-24-10		3-83-11		3-44-12		3-29-13		3-21-14		4-43	-5	
79	59	79	49	79	76	79	50	79	33	79	7	47	19	
4-10	-9	4-26-10		4-76-11		4-67-12		4-49-13		4-64-14		5-28	-9	
47	59	47	49	47	76	47	50	47	33	47	7	19	59	
5	-0-10	5-49-11		5-42-12		5-48-13		5-29-14		9-14-10		9-12-11		
19	49	19	76	19	50	19	33	19	7	59	49	59	76	
9-50-12		9-34-13		9	-0-14	10-33-11		10	-0-12	10	-0-13	10	-9-14	
59	50	59	33	59	7	49	76	49	50	49	33	49	7	
11-43-12		11-36-13		11-44-14		12-75-13		12-24-14		13-25-14				
76	50	76	33	76	7	50	33	50	7	33	7			

Fig. 7.—Degree of Overlapping of Common Causal Elements Between Fatigue Testers.

veys, we cannot be content with predicting fatigue results from breaking strength and elongation data. There remain unknown elements shared by the testers discussed.

Little is to be gained by considering the conditioned breaking strength, the stretches, etc. Tire-test data, together with intimate details of the operating mechanisms, would give valuable clues, but, lacking such data, we cannot identify the common elements.

However, we can illustrate the interlocking of causal elements in another way, the details of which may be found in treatises on statistical analysis.[4]

Let us suppose we are comparing two measures of fatigue resistance and that we find the causes of failure are the elements X_1, X_2, ... X_n where the X's are, say, strength, stretchability, toughness, brittleness, friction, heat, moisture, sunspots, or anything else you may think of as contributing. Then the one measure Y_1 is some function of these elements, say,

$$Y_1 = Y_1(X_1 \ldots . X_n)$$

and the other measure is another function of the elements

$$Y_2 = Y_2(X_1 \ldots . X_n)$$

where any one of the elements named, say X_p, may or may not appear in both functions. Have we any way of estimating how many of the elements the two Y's have in common?

Yes, statistical analysis[5] indicates that the square of the coefficient of correlation between the two Y's, expressed as a percentage, is an index of the degree of overlapping of causal elements.

The results of the computations are given in Fig. 7, which can be understood only by use of the key given just below. Let us consider, first, two testers which we are reasonably sure have much in common—the two folding testers, Nos. 12 and 13. Here between the numbers of the testers being compared we have written the square of the correlation coefficient as a percentage—the index of overlapping causal elements. This figure says that of all the fundamental elements contributing to failure in the two tests, 75 per cent are held in common.

Just below the tester number we include the degree of overlapping with "breaking strength and elongation." These three indices indicate that testers Nos. 12 and 13 have in common more elements than are included in the factor "breaking strength and elongation."

Let us take another extreme case by comparing testers Nos. 10 and 12. It is indicated that these two testers have nothing in common although each depends upon the factor breaking strength and elongation to some extent. We interpret this result to mean that although both testers depend upon elements which influence the breaking strength and elongation tests, they do not depend on the same elements.

Testers Nos. 9 and 11 constitute another pair which have very little in common, although each has in it many of the elements which influence breaking strength and elongation.

On the other hand, testers Nos. 1 and 2 have considerable in common even though No. 2, the Goodyear tube, is independent of breaking strength and elongation. Herein we believe, lies the value of this particular analysis—to detect clues to otherwise hidden common causes. Let us consider testers Nos. 9 and 10—the new Firestone and the Abrasion—which we found to have an appreciable negative correlation coefficient.

Here we find that they have very little in common even though each has quite a bit in common with breaking strength and elongation. Shall we say that negative coefficient was not so significant as we thought, that these two testers do not measure the same property? We cannot assume enough knowledge of the mechanism of either tester to answer the question.

Referring back to tester No. 1, and looking at the index of overlapping of causal elements, we find 52, 69, 72, 33, 35, 27, 75, 57, 45, and 49 per cent. In general, we find some, to appreciable, overlapping of common elements—a higher level than we can see when comparing the other testers.

There is much information in Fig. 7 and much to be gained by this type of analysis. The only point to be emphasized here is that these 14 diverse testers have many elements in common and that breaking strength tests cannot account for all of the common elements.

This point can be demonstrated in another way as in Fig. 8. Here we have information which was given earlier but arranged in a different fashion—the coefficients of correlation between testers. (Of course, the items below the diagonal are identical with those above.) Starting with tester No. 1, we see a general high level of correlation—the coefficient does not drop below 50 per cent.

Tester No. 2 correlates better with No. 1 than with any other tester. Number 3 correlates with No. 11 better than with No. 1; only one other tester (No. 11) correlates better with No. 4 than does No. 1. Number 5 correlates with five others better than with No. 1, but does not correlate at all with No. 10,

[4] H. E. Garrett, "Statistics in Psychology and Education," Longmans, Green and Co. first ed., pp. 291–294 (July, 1935).

[5] *Ibid.*; Mordecai Ezekiel, "Methods of Correlation Analysis," John Wiley & Sons, Inc., second ed., p. 139 (1941).

	1	2	3	4	5	9	10	11	12	13	14	
1		72	83	85	57	59	52	87	75	67	70	GOODRICH
2	72		41	64	36	43	17	45	64	51	61	GOODYEAR TUBE
3	83	41		73	63	58	49	91	66	54	46	AVC OLD FIRESTONE
4	85	64	73		66	31	51	87	82	70	80	AVC BROSAM
5	57	36	63	66		53	0	70	65	69	54	DUPONT USR
9	59	43	58	31	53		-37	34	71	59	0	FIRESTONE NEW
10	52	17	49	51	0	-37		58	0	0	30	AD LITTLE ABRASION
11	87	45	91	87	70	34	58		65	60	66	NORTH AMERICAN
12	75	64	66	82	65	71	0	65		87	49	AD LITTLE FOLDING
13	67	51	54	70	69	59	0	60	87		50	RIORDAN FOLDING
14	70	61	46	80	54	0	30	66	49	50		RIORDAN BENDING
			AVERAGE	VALUE	OF	COEFFICIENT						
	71	49	62	69	53	37	22	65	62	57	51	WITH 1
		47	60	67	53	35	19	64	61	56	48	WITHOUT 1

Fig. 8.—Coefficient of Correlation Between Fatigue Testers.

and correlates very poorly with No. 2.

Testers Nos. 9 and 10 correlate better with one other tester, each, than with No. 1 but each shows some very poor correlations. Number 11 shows respectable correlation except for one poor value (34 per cent with No. 9). The two folding testers correlate very well with each other, and No. 12 with one other, No. 13 with two others, better than with No. 1. Number 14 agrees with No. 4 better than with No. 1.

The average value of the coefficient should be an index of the level of correlation. As given in the two lines below the square array, the correlation of tester No. 1 with the others is the best of the lot, and including No. 1 raises the level of correlation of the others.

There is much interesting information to be gained from Venable's data by this type of analysis. However, we believe we have given the significant features of the analysis. Our results may be summarized as follows:

Although we cannot determine which tester most satisfactorily predicts tire performance we find remarkable agreement among them. We find that the factors, breaking strength, and elongation, are important elements in many of the tests, but that all the fatigue results cannot be predicated on them for any tester; in some cases even the fatigue results are independent of these factors. Therefore we conclude that there are other, unknown, elements.

Finally, we find that one tester is outstanding in its correlation with the others, that the B. F. Goodrich Tension Vibrator gives to a marked degree the information given by every one of the other eleven testers.

It should be pointed out that the analysis presented in this paper rests upon limited data obtained from 14 rayon cords from one manufacturer, and it does not necessarily follow that the same relationships would hold for cotton cords, or cords made of other textile materials.

A Suggested Method for Thorough Testing of Antiseptic Fabrics[1]

By Louis C. Barail[2]

THE interest of manufacturers of knitted and woven fabrics on antiseptics capable of rendering these fabrics permanently bacteriostatic and germicidal has been greatly increased during the past two years. Many compounds have been tested for this purpose, inorganic compounds, organic compounds, metallo-organic compounds, but very few of them could meet the two principal requirements set up by textile manufacturers, namely, very low toxicity and resistance to multiple washings. Besides these two principal requirements knitters and weavers strongly object to the use of chemicals that have a strong odor or change the color of treated fabrics.

A few of these chemicals cannot be used because of odor, color, or high toxicity or because they react on dyes, finishes, sizes, water repellents, etc., during the manufacturing process, although they give a good performance after a certain number of washings. On the other hand, many others that could be accepted because of their lack of odor, color, and their very low toxicity have to be rejected because they readily wash out of the fabric at the first or second washing. We have tested over 250 of these chemicals and for the reasons mentioned above we

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to A.S.T.M. Headquarters, 260 S. Broad St., Philadelphia 2, Pa.

[1] Abstract of paper presented at the October, 1944, meeting of Committee D-13 on Textile Materials.

[2] United States Testing Co., Inc., Hoboken, N.J.

have found only one group that meets the requirements of the manufacturers for high performance including resistance to washings, low toxicity, no objectionable odor, and no coloring of the treated fabric. These chemicals are the antiseptics of the phenyl mercury group.

TABLE I.—TESTS PERFORMED ON FABRICS.

A. Informative Tests	
Toxicity: (1) Minimum lethal dose Skin irritants: (2) Animal injection test Sensitizers: Antiseptic value: (4) Determination of phenol coefficient	(3) Patch Tests
B. Performance Tests	
All tests are conducted on fabrics as received and after up to 30 washings.	
1. Sterility	
2. Bacteriostasis against *Staphylococcus aureus*, *Eberthella typhosa*, *Escherichia coli*	
3. Bactericidal value after contamination with *E. coli*	
4. Fungistasis against *Tricophyton gypseum*	
5. Fungicidal value against *Tricophyton gypseum*	

Description of Tests

When a fabric treated with an antiseptic, or an antiseptic for the treatment of a fabric, is submitted to us, we conduct two groups of tests. The first group which we will not discuss in full we call the informative tests. They are listed in Table I, along with the second group consisting of the various performance tests, which will be described in detail.

Performance Tests

All performance tests are conducted on the fabrics as soon as they have been treated and dried and also after they have been submitted to a certain number of washings. This number of washings can be as high as 40, but we have not yet found any compound that would pass *all* tests within the limits of toxicity.

All washings are done in the Launder-Ometer at temperatures varying from 105 F. for delicate fabrics to 160 F. for heavier fabrics. The washing time varies from 2 min. for delicate fabrics to 15 min. for the heaviest fabrics. The fabrics are then rinsed twice, extracted, and dried either in the open air, in a dryer, or by ironing with a cool iron.

Four compounds, all phenyl mercury derivatives, have been studied in this series of tests. Compounds 1, 2, and 3 were used at a concentration of 1 per cent, Compound 4 was used at a concentration of 0.5 per cent. All fabrics were treated with a mixture of the compounds at the above-mentioned concentrations and 2 per cent of a wetting agent.

Except for the difference in concentration due to the greater strength of Compound 4, the same procedure and the same conditions were used during all tests for all fabrics treated with the various compounds. These conditions include the bacteriological work and the washing procedure, the strength of the cultures, the temperature of washing and incubation, and the formulas of broth, agar, and other chemicals used during the test.[3]

After drying, the fabrics are subjected to the following performance tests:

1. *Sterility Test:*

Three disks ½ in. in diameter are cut from the samples immediately after treatment and after each washing or after each group of five washings. Each disk is then placed in a tube containing 10 cu. cm. of sterile bacto-nutrient broth and incubated for 10 days at 37 C. At the end of the incubation period, the tubes are examined for growth. It is necessary to point out that the fabrics are handled *without* aseptic precautions during the test. As controls, three disks ½ in. in diameter of the untreated fabric are placed in tubes also containing 10 ml. of sterile bacto-nutrient broth and incubated with the treated samples for 10 days at 37 C. At the end of this period, they are examined with the treated samples for presence of growth.

Table II gives the results of sterility tests conducted on four antiseptic compounds meeting the Toxicity and the Patch Tests requirements and advertised by their manufacturers as giving a permanent protection to fabrics against bacteria and fungi.

The above tests definitely show that there is not only a great difference in performance among the four products, but also between the two fabrics treated with the same compound. This difference is particularly noticeable between the two fabrics treated with Compound 1. The best performance in the Sterility Test is that of Compound 4 which insures sterility to one type of fabric after 30 washings and to the other type after 25 washings.

TABLE II.—RESULTS OF STERILITY TEST.
− Indicates the absence of growth.
+ Indicates the presence of growth.

As Received	After 5 Washings	After 10 Washings	After 15 Washings	After 20 Washings	After 25 Washings	After 30 Washings
Compound 1						
Fabric A						
−	−	−	−	−	+	+
−	−	−	−	−	+	+
−	−	−	−	−	+	+
Fabric B						
−	−	+	+	+	+	+
−	−	+	+	+	+	+
−	−	+	+	+	+	+
Compound 2						
Fabric A						
−	−	−	−	−	+	+
−	−	−	−	−	+	+
−	−	−	−	−	+	+
Fabric B						
−	−	−	−	−	+	+
−	−	−	−	−	+	+
−	−	−	−	−	+	+
Compound 3						
Fabric A						
−	−	−	−	−	+	+
−	−	−	−	−	+	+
−	−	−	−	−	+	+
Fabric B						
−	−	−	+	+	+	+
−	−	−	+	+	+	+
−	−	−	+	+	+	+
Compound 4						
Fabric A						
−	−	−	−	−	−	−
−	−	−	−	−	−	−
−	−	−	−	−	−	−
Fabric B						
−	−	−	−	−	−	+
−	−	−	−	−	−	+
−	−	−	−	−	−	−

2. *Bacteriostasis against Staphylococcus aureus, Eberthella typhosa, and Escherichia coli:*

Three disks $\frac{5}{8}$ in. in diameter are cut from the fabrics after treatment and after each washing or group of washings. They are then plated in Petri dishes in agar planted with fresh test cultures of *Staphylococcus aureus*, *Eberthella typhosa*, and *Escherichia coli*. They are incubated at 37 C. and after 36-hr. incubation the plates are examined for bacteriostasis. The width of the zone of inhibition measured in millimeters indicates the diffusibility and, consequently, the bacteriostatic value of the samples. It is currently admitted that a zone of inhibition of less

[3] The test was conducted on two knitted treated fabrics, fabric A containing 90 per cent cotton and 10 per cent wool fibers, and fabric B containing 100 per cent cotton fibers.

than 1 mm. indicates a poor bacteriostasis. The bacteriostatic value is considered as fair from 1 to 3 mm.; good from 3 to 6 mm.; very good from 6 to 9 mm.; and excellent above 9 mm.

Table III indicates the results obtained on fabrics treated with the same compounds as above. The bacteriostatic tests show that only fabrics treated with Compound 4 have a good bacteriostatic value after 30 washings.

TABLE III.—RESULTS OF BACTERIOSTATIC TEST.

Number of Washings	*Staphylococcus aureus*, mm.	*E. typhosa*, mm.	*E. coli*, mm.
Compound 1			
Fabric A			
As received	11.5	9.5	9.0
5	9.5	8.5	6.5
10	6.5	4.5	3.5
15	5.5	3.0	1.0
20	1.0	0.0	0.0
Fabric B			
As received	11.0	9.0	8.5
5	9.0	8.0	6.0
10	6.0	4.0	3.0
15	5.0	2.5	0.5
20	0.5	0.0	0.0
Compound 2			
Fabric A			
As received	11.5	9.5	8.5
5	9.5	7.0	6.0
10	6.5	4.5	3.5
15	...	2.5	0.5
20	1.5	0.0	0.0
Fabric B			
As received	11.0	9.0	8.0
5	9.0	6.5	5.5
10	6.0	4.0	2.5
15	5.0	2.0	0.0
20	1.0	0.0	0.0
Compound 3			
Fabric A			
As received	11.5	8.5	8.5
5	9.5	6.5	5.0
10	5.5	3.5	2.0
15	3.5	3.0	0.5
20	2.5	0.0	0.0
Fabric B			
As received	11.0	8.0	8.0
5	9.0	6.0	4.5
10	5.0	3.0	1.5
15	3.0	2.5	0.0
20	2.0	0.0	0.0
Compound 4			
Fabric A			
As received	7.0	6.5	10.5
5	6.5	5.5	10.0
10	5.0	4.5	10.0
15	4.5	4.0	8.5
20	4.5	4.0	7.0
25	4.0	3.5	6.5
30	5.5	3.5	6.5
Fabric B			
As received	7.0	6.5	10.0
5	6.0	5.0	9.0
10	5.5	4.5	8.0
15	5.0	4.0	7.5
20	4.5	3.5	5.0
25	4.5	3.5	4.5
30	3.5	3.0	4.0

3. *Bactericidal Value after Contamination:*

The purpose of this test is to determine whether fabrics treated with antiseptics have germicidal properties and retain these germicidal properties after a certain number of washings. This test is a very severe one, since all fabrics are contaminated with a fresh test culture of *E. coli* by total immersion before being submitted to the tests. *E. coli* has been chosen for this test because it is the most resistant of the three standard test organisms, the two others being *Staphylococcus aureus* and *Eberthella typhosa*.

The test is conducted as follows:

Six disks $\frac{5}{8}$ in. in diameter are cut from each fabric after treatment and after each washing or after each group of five washings. They are placed successively in a tube containing 5 ml. of a 24-hr. standard culture of *E. coli* for 1 min. Upon removal the first disk is placed with aseptic precautions in a tube of sterile nutrient broth and swirled for 5 min., removed to a second tube of sterile nutrient broth and swirled for 10 sec., and finally transferred to a third tube of sterile broth. All three tubes are incubated for 48 hr. at 37 C.

A second disk upon removal from the contaminated tube is treated as the first one except that all three tubes are incubated at 20 C. for 48 hr.

The third disk is transferred to a tube of sterile broth for 10 min., then to a second tube of sterile broth for 10 sec., and then removed to a third tube of sterile broth. All three tubes are incubated for 48 hr. at 37 C. The fourth disk is treated as the third one, but all tubes are incubated at 20 C. for 48 hr.

The fifth disk is transferred to a tube of sterile broth for 15 min., placed in a second tube of sterile broth for 10 sec., and then removed to a third tube of sterile broth. All three tubes are incubated at 37 C. for 48 hr. The sixth disk is treated as the fifth one, but all three tubes are incubated for 48 hr. at 20 C.

Subcultures made from the transfer tubes were made during our first contamination tests. They have always confirmed the results obtained in the transfer tubes, and for this reason we consider that they are not necessary.

As controls six disks $\frac{5}{8}$ in. in diameter are cut from the untreated fabric and handled exactly the same way as the six treated samples described above. Six more disks of the same diameter are also cut from a swatch of the same fabric treated with a 1:60 solution of phenol and dried. They are then handled exactly the same way as the six treated samples previously described.

After 48 hr. of incubation all tubes are examined for the presence of growth.

The following Table IV indicates the results obtained with fabrics treated with the compounds mentioned above after incubation at both 37 and 20 C. They show great differences in germicidal power among the tested compounds.

It is obvious that Compound 4, although used at one half the concentration of all other compounds and slightly more than one fourth the concentration of the phenol control is the strongest of all tested compounds. One treated fabric was still bactericidal after 30 washings, after 5 min. at both 37 and 20 C. The other type of fabric was still bactericidal after 30 washings after 5 min. at 20 C. and after 25 washings after 5 min. at 37 C.

4. *Fungistatic Tests:*

The purpose of these tests is to determine whether fabrics treated with antiseptics have fungistatic properties and retain these properties after a certain number of washings. All kinds of fungi can be used for this test. However, we believe that since in most cases these fabrics are likely to come in contact with the skin it is preferable to use a pathogenic fungus and for this reason we conduct our tests with a member of the *Tricophyton* group. We have selected the most common and one of the most resistant of all, namely *Tricophyton gypseum*. The test is an adaptation to fungi of the method outlined for bacteriostasis in Bulletin 198 of the U. S. Department of Agriculture and previously described. These tests show that fabrics treated with Compound 4 have better fungistatic properties

TABLE IV.—RESULTS OF BACTERICIDAL TESTS.

− Indicates the absence of growth.
+ Indicates the presence of growth.

Number of Washings	5 min.	10 min.	15 min.	First Control Sample, Untreated	Second Control Sample, Treated with 1:60 Phenol		
					5 min.	10 min.	15 min.
COMPOUND 1							
Fabric A							
Incubation at 37 C.							
As received	−	−	−	+	−	−	−
5	−	−	−	+	+	+	+
10	−	−	−	+	+	+	+
15	+	+	+	+	+	+	+
20	+	+	+	+	+	+	+
Incubation at 20 C.							
As received	−	−	−	+	+	+	+
5	−	−	−	+	+	+	+
10	−	−	−	+	+	+	+
15	−	−	−	+	+	+	+
20	−	−	−	+	+	+	+
Fabric B							
Incubation at 37 C.							
As received	−	−	−	+	−	−	−
5	+	+	+	+	+	+	+
10	+	+	+	+	+	+	+
15	+	+	+	+	+	+	+
20	+	+	+	+	+	+	+
Incubation at 20 C.							
As received	−	−	−	+	+	+	+
5	+	+	+	+	+	+	+
10	+	+	+	+	+	+	+
15	+	+	+	+	+	+	+
20	+	+	+	+	+	+	+
COMPOUND 2							
Fabric A							
Incubation at 37 C.							
As received	−	−	−	+	−	−	−
5	+	+	+	+	+	+	+
10	+	+	+	+	+	+	+
15	+	+	+	+	+	+	+
20	+	+	+	+	+	+	+
Incubation at 20 C.							
As received	−	−	−	+	+	+	+
5	−	−	−	+	+	+	+
10	−	−	−	+	+	+	+
15	−	−	−	+	+	+	+
20	+	+	+	+	+	+	+
Fabric B							
Incubation at 37 C.							
As received	+	−	−	+	−	−	−
5	+	+	+	+	+	+	+
10	+	+	+	+	+	+	+
15	+	+	+	+	+	+	+
20	+	+	+	+	+	+	+
Incubation at 20 C.							
As received	−	−	−	+	+	+	+
5	−	−	−	+	+	+	+
10	−	−	−	+	+	+	+
15	−	−	−	+	+	+	+
20	+	+	+	+	+	+	+
COMPOUND 3							
Fabric A							
Incubation at 37 C.							
As received	−	−	−	+	−	−	−
5	−	−	−	+	+	+	+
10	−	−	−	+	+	+	+
15	−	−	−	+	+	+	+
20	+	+	+	+	+	+	+
Incubation at 20 C.							
As received	−	−	−	+	+	+	+
5	−	−	−	+	+	+	+
10	+	+	−	+	+	+	+
15	+	+	−	+	+	+	+
20	+	+	−	+	+	+	+
Fabric B							
Incubation at 37 C.							
As received	−	−	−	+	−	−	−
5	−	−	−	+	+	+	+
10	+	+	+	+	+	+	+
15	+	+	+	+	+	+	+
20	+	+	+	+	+	+	+
Incubation at 20 C.							
As received	−	−	−	+	+	+	+
5	−	−	−	+	+	+	+
10	−	−	−	+	+	+	+
15	+	+	+	+	+	+	+
20	+	+	+	+	+	+	+
COMPOUND 4							
Fabric A							
Incubation at 37 C.							
As received	−	−	−	+	−	−	−
5	−	−	−	+	+	+	+
10	−	−	−	+	+	+	+
15	−	−	−	+	+	+	+
20	−	−	−	+	+	+	+
25	−	−	−	+	+	+	+
30	−	−	−	+	+	+	+
Incubation at 20 C.							
As received	−	−	−	+	+	+	+
5	−	−	−	+	+	+	+
10	−	−	−	+	+	+	+
15	−	−	−	+	+	+	+
20	−	−	−	+	+	+	+
25	−	−	−	+	+	+	+
30	−	−	−	+	+	+	+
Fabric B							
Incubation at 37 C.							
As received	−	−	−	+	−	−	−
5	−	−	−	+	+	+	+
10	−	−	−	+	+	+	+
15	−	−	−	+	+	+	+
20	−	−	−	+	+	+	+
25	−	−	−	+	+	+	+
30	+	+	+	+	+	+	+
Incubation at 20 C.							
As received	−	−	−	+	+	+	+
5	−	−	−	+	+	+	+
10	−	−	−	+	+	+	+
15	−	−	−	+	+	+	+
20	−	−	−	+	+	+	+
25	−	−	−	+	+	+	+
30	−	−	−	+	+	+	+

against *Tricophyton gypseum* than those treated with the other tested compounds.

TABLE V.—RESULTS OF FUNGISTATIC TESTS.

Fabric	As received, mm.	After 5 Washings, mm.	After 10 Washings, mm.	After 15 Washings, mm.	After 20 Washings, mm.
			Compound 1		
A...	11	7	5	3.5	2
	11.5	7	6	4.0	3
	10.0	5	5	3.0	2
B...	29	25	17	4.0	0
	32	23	16	9.0	0
	33	26	17	8.0	0
			Compound 2		
A...	24	17	16	15	12
	24	16	15	15	11
	25	17	16	15	11
B...	31	26	15	10	0
	32	27	15	6	0
	31	25	14	7	0
			Compound 3		
A...	26	20	20	16	15
	26	25	21	17	16
	24	22	20	14	12
B...	30	25	17	7	0
	33	29	10	10	0
	31	30	12	4	1
			Compound 4		
A...	12	7	7	6.0	5
	12	9	8	5.0	3
	11	5	8	6.0	3
B...	10	8	3	3.0	3
	11	7	5	4.0	2.5
	8	5	6	5.0	3

5. *Fungicidal Tests:*

When fabrics treated with antiseptics show a sufficient fungistatic value it is interesting to find out whether these antiseptics have only imparted fungistatic properties to the fabric, or if these fabrics have also fungicidal properties.

The method used is as follows. At the completion of the fungistatic test subcultures are taken from each Petri dish with a platinum loop as exactly as possible halfway between the edge of the fabric and the edge of the inhibition zone. They are then inoculated in sterile slants of Sabouraud's maltose agar. The tubes are incubated for seven days and at the expiration of this period examined for the presence of growth. Growth in the tube indicates that the normal growth of the fungus was inhibited as long as the fabric was in contact with the agar, but that the fungus was not destroyed. Absence of growth in the tube indicates that not only the fabric inhibited the growth of the fungus but actually killed it.

TABLE VI.—RESULTS OF FUNGICIDAL TESTS.

Fabric	As Received	After 5 Washings	After 10 Washings	After 15 Washings	After 20 Washings
			Compound 1		
A.....	Growth	Growth	Growth	Growth	Growth
	Growth	Growth	Growth	Growth	Growth
	Growth	Growth	Growth	Growth	Growth
B.....	No growth	No growth	No growth	Growth	Growth
	No growth	No growth	No growth	Growth	Growth
	No growth	No growth	No growth	Growth	Growth
			Compound 2		
A.....	No growth	No growth	No growth	No growth	Growth
	No growth	No growth	No growth	No growth	Growth
	No growth	No growth	No growth	No growth	Growth
B.....	No growth	No growth	No growth	Growth	Growth
	No growth	No growth	No growth	Growth	Growth
	No growth	No growth	Growth	Growth	Growth
			Compound 3		
A.....	No growth	No growth	Growth	Growth	Growth
	No growth	Growth	Growth	Growth	Growth
	No growth	Growth	No growth	Growth	Growth
B.....	No growth	No growth	No growth	Growth	Growth
	No growth	No growth	No growth	Growth	Growth
	No growth	No growth	No growth	Growth	Growth
			Compound 4		
A.....	No growth	No growth	No growth	No growth	No growth
	No growth	No growth	No growth	No growth	No growth
	No growth	No growth	No growth	No growth	No growth
B.....	No growth	No growth	No growth	No growth	Growth
	No growth	No growth	No growth	No growth	Growth
	No growth	No growth	No growth	No growth	Growth

Table VI reports results obtained on fabrics treated with the samples submitted to fungicidal tests after fungistatic tests as above described. They show that fabrics treated with Compound 4 retain their fungicidal properties after a greater number of washings than fabrics treated with any of the other tested compounds.

Table VII is a condensation of all results obtained in the various tests. It clearly shows the comparative value of the tested compounds for each particular test.

In Table VIII we have listed these compounds according to value, and Table IX gives the final score of all tests. It definitely demonstrates the superiority of Compound 4 in all tests, and calls for a few comments.

The four tested compounds are relatively new and are considered as big improvements in the line of phenyl mercuric compounds. The compounds were numbered according to their appearance on the industrial market, the oldest being given number one and the most recent, number four.

It is very interesting to note that the results of the tests exactly coincide with the history of the compounds, the oldest being the least efficient, the newest giving the best performances.

Another interesting fact is that the manufacturers of Compounds 1, 2, and 3, have not improved their products for several years, nor have they produced better compounds than the old ones. On the other hand, Compound 4 is the result of a long chemical research program conducted by the manufacturers of two compounds which are already as good as, if not better than, Compound 3, and have been on the market for several years.

In order to make this paper as short as the subject permits, we have not described the informative tests, nor have we given any results on the informative tests conducted on the compounds. However, the results of these tests for toxicity, skin irritants, skin sensitizers, and phenol coefficient, are best for Compound 4, the most recent one, and worst for Compound 1, the oldest one.

Conclusions

The method we have suggested for the thorough testing of fabrics treated with antiseptics permits to evaluate in dollars and cents the cost of processing as related to per-

TABLE VII.—RECAPITULATIVE RESULTS.

STERILITY TESTS

Compound	Concentration, per cent	Maximum Number of Washings	
		Fabric A	Fabric B
1	1	20	5
2	1	20	20
3	1	20	10
4	½	30	25

BACTERIOSTATIC TESTS

Compound	Concentration, per cent	Maximum Number of Washings Showing a Minimum of 3 mm. Inhibition Against:		
		Staphylococcus aureus	*E. typhosa*	*E. coli*
Fabric A				
1	1	15	15	10
2	1	15	10	10
3	1	15	15	5
4	½	30	30	30
Fabric B				
1	1	15	10	10
2	1	15	10	5
3	1	15	10	5
4	½	30	30	30

BACTERICIDAL VALUE AFTER CONTAMINATION

Compound	Concentration, per cent	Maximum Number of Washings			
		Fabric A		Fabric B	
		37 C.	20 C.	37 C.	20 C.
1	1	10 (5 min.)	20 (5 min.)	0 (5 min.)	0 (5 min.)
2	1	0 (5 min.)	15 (5 min.)	0 (5 min.)	10 (5 min.)
3	1	15 (5 min.)	20 (15 min.)	5 (5 min.)	10 (5 min.)
4	½	30 (5 min.)	30 (5 min.)	25 (5 min.)	30 (5 min.)

FUNGISTATIC TESTS

Compound	Concentration, per cent	Maximum Number of Washings Showing a Minimum of 3 mm. Inhibition against *T. gypseum*	
		Fabric A	Fabric B
1	1	15	15
2	1	20	15
3	1	20	15
4	½	20	20

FUNGICIDAL TESTS

Compound	Concentration, per cent	Maximum Number of Washings	
		Fabric A	Fabric B
1	1	Growth as is	10
2	1	15	5
3	1	0 (no growth)	10
4	½	20	15

TABLE VIII.—LISTING OF TESTED COMPOUNDS ACCORDING TO VALUE.

Concentration: Compounds 1, 2, 3 = 1 per cent.
Compound 4 = ½ per cent.

STERILITY TESTS

	Fabric A	Fabric B
First	Compound 4	Compound 4
Second	Compound 1 Compound 2 Compound 3	Compound 2
Third		Compound 3
Fourth		Compound 1

BACTERIOSTATIC TESTS

	Fabric	*Staphylococcus aureus*	*E. typhosa*	*E. coli*
First	A	Compound 4	Compound 4	Compound 4
	B	Compound 4	Compound 4	Compound 4
Second	A	Compounds 1, 2, 3	Compounds 1, 3	Compounds 1, 2
	B	Compounds 1, 2, 3	Compounds 1, 2, 3	Compound 1
Third	A	.....	Compound 2	Compound 3
	B	.....	.....	Compounds 2, 3

BACTERICIDAL VALUE AFTER CONTAMINATION

	Fabric A		Fabric B	
	37 C.	20 C.	37 C.	20 C.
First	Compound 4	Compound 4	Compound 4	Compound 4
Second	Compound 3	Compounds 1, 3	Compound 3	Compounds 2, 3
Third	Compound 1	Compound 2	Compounds 1, 2	Compound 1

FUNGISTATIC TESTS

	Fabric A	Fabric B
First	Compounds 2, 3, 4	Compound 4
Second	Compound 1	Compounds 1, 2, 3

FUNGICIDAL TESTS

	Fabric A	Fabric B
First	Compound 4	Compound 4
Second	Compound 2	Compounds 1, 3
Third	Compound 3	Compound 2
Fourth	Compound 1	

TABLE IX.—RÉSUMÉ OF PERFORMANCES.

Compound	Concentration, per cent	Number of Tests			
		First Place	Second Place	Third Place	Fourth Place
4	½	16	0	0	0
3	1	1	11	4	0
2	1	1	9	5	1
1	1	0	11	3	2

formance. The claims of the manufacturers of the four tested compounds are identical in spirit, if not in wording, and yet one is almost twice as active at a concentration of ½ per cent than any one of the three others at a concentration of 1 per cent. Since the cost of the original products is approximately the same, such tests insure textile manufacturers a saving of approximately 75 per cent.

The method has been here described in conjunction with phenyl mercury derivatives, because washing tests were being studied, and only a few phenyl mercuric compounds do impart permanent antiseptic properties to fabrics. However, it can be used to test all kinds of antiseptics, of inorganic, organic or organo-inorganic nature, and it will always give accurate and reproducible results.

Metal Cleaning: II—Soil Removal Performance Methods

By Jay C. Harris[1]

Cooperators:
Claudius Nielson, Nielco Laboratories; B. S. Van Zile, et al., Hercules Powder Co.; C. S. Lowe, Pennsylvania Salt Manufacturing Co.; R. S. Frazer and M. P. Boland, Cowles Detergent Co.; A. H. Baldwin, Hansen-Van Winkle-Munning Co.; and C. C. Ross, U. S. Naval Engineering Experiment Station.

EDITOR'S NOTE: This paper is a continuation of a paper on "Metal Cleaning: I—Indirect Performance Tests," which was published in ASTM BULLETIN, No. 133, March, 1945, p. 23.

IT IS not the purpose of these papers on metal cleaning to suggest either that direct performance methods, or laboratory soil removal evaluation tests should be considered the only criteria for choice of cleaner: They are intermediate evaluation or control methods. The only true method to provide a significant answer for final choice is to determine how effectively and economically actual soil is removed in plant practice over a period of time and under adequate control. It is the purpose of these papers to provide pertinent data on evaluation methods so that improved laboratory technique may result, with the ultimate object of providing improved cleaners for commercial usage. Consequently none of the indirect performance tests nor the soil removal tests to be described should in any sense be considered as "standards" of the society.

These papers are necessary to a thorough evaluation of present technique and it is hoped that their publication will result in constructive criticism which will further the work of Section G on Metal Cleaners of Subcommittee II on Specifications of the A.S.T.M. Committee D-12 on Soaps and Other Detergents.

The indirect approach to the metal cleaning problem by measurement of physical, chemical, or physicochemical properties of a cleaning composition was dealt with in Part I of this paper.[2] The present portion of the paper will attempt to cover the direct evaluation of metal cleansers by measurement of their relative ability to remove a given soil by laboratory methods. This approach yields an immediate answer, when applied to soiled surface in question, but may leave unanswered the problem of whether such a composition will remove a soil of other, perhaps quite dissimilar, characteristics. The factor of the soil chosen for such a method of evaluation then becomes most important.

The types of soil or foreign matter generally encountered have been classified (94):[3]

1. Mineral oil blanking lubricant.
2. Pure oil of a compounded type used in drilling and tapping, or on automatic screw machines.
3. Soap emulsions used in milling, blanking, pressing, etc.
4. Heavy soap-base drawing compounds.

Other soiling materials may comprise:

5. Buffing compound constituents.
6. Graphite drawing compounds.
7. Carbonized oils, greases, or food products.
8. Asphaltic and tarry materials.
9. Corrosion products deposited on, or from the metal being cleaned.
10. Food residues, beer-stone, milk-stone, etc.
11. Paints, varnishes, waxes, etc.

From the variety of materials listed it is apparent that the soil present may have considerable bearing upon the cleaning method and materials chosen. This is not the only criterion used in a choice of method, since the metal surface being cleansed may be important. Perhaps the most important factor, however, is choice of method to remove the specific soil from the specified metal adequately, at minimum cost.

A condensed classification of the different cleaning methods follows:

1. Soak tank cleaning.
2. Mechanical tank or spray cleaning.

NOTE.—DISCUSSION OF THIS REPORT IS INVITED, either for publication or for the attention of the author. Address all communications to A.S.T.M. Headquarters, 260 S. Broad St., Philadelphia 2, Pa.

[1] Chairman Section G on Metal Cleaners, Subcommittee II on Specifications, Committee D-12 on Soaps and Other Detergents; Monsanto Chemical Co., Dayton, Ohio.

[2] Jay C. Harris, "Metal Cleaning: I—Indirect Performance Tests," ASTM BULLETIN, No. 133, March, 1945, p. 23.

[3] The boldface numbers in parentheses from Nos. 1 to 209 refer to the "Annotated Bibliography of Aluminum Cleaning," ASTM BULLETIN, No. 120, January, 1943, p. 33; No. 121, March, 1943, p. 33; and No. 128, May, 1944, p. 35. References from Nos. 210 to 238 are appended to "Metal Cleaning: I—Indirect Performance Tests," ASTM BULLETIN, No. 133, March, 1945, p. 23. References Nos. 239 to 243 are appended to the present paper.

3. Electrolytic cleaning.
4. Solvent or vapor degreasing.
5. Emulsion degreasing.

Use of this classification in combination with knowledge of the type of soil present, and ease of its removal, is a more logical approach to the problem, since several general types or even combinations of types of cleaning may advantageously be used.

Since one or more of these cleaning methods may be used, the need is thus exemplified for some means for evaluating these methods either on a semi-plant scale, if available, or in the laboratory. Resort to semi-plant or laboratory scale evaluation will eventually lead to a desire for more uniformly soiled pieces for trial purposes which in the semi-plant scale may mean segregation of representative pieces from stock. The laboratory is not always so fortunately situated, and desire for uniformity of test results almost invariably leads to application of a soil under more or less well-controlled conditions of application, dependent upon analysis of the problem and knowledge of the resultant effects.

Application of a "standard" soil implies perfect control of all factors involved, as well as full control of all subsequent operations, since the ultimate object of such a test leads to the desire to obtain reproducible results of known variability.

Faced with the many types of soil which must be removed, we might at once arrive at the deduction that no "standard" soil or "standard" test could be devised. The fact that many investigators have published results with one or another type of soil, however, only emphasizes the need for such a test or tests. Unfortunately, many such papers fail to outline fully test conditions and few make any attempt to indicate the sensitivity and reproducibility of their chosen method of operation. Such criticism leads to the suggestion that available information be correlated, so that all pertinent data be tabulated for ease of comparison.

The published laboratory methods for soil removal evaluation were arbitrarily classified on the basis either of the method for soil removal, or upon the soil itself:

A. Oil removal,
B. Solvent emulsion method,
C. Electrolytic method,
D. Carbon removal,
E. Friction removal, and
F. Paint stripping.

Though this classification may overlap, and does not represent all the available procedures, the methods of operation used for one type may be applicable, under altered conditions, to another type of cleansing.

No attempt has heretofore been made to evaluate the available methods dealing with soil removal from metal surfaces. This paper therefore makes an attempt to subject them to such an analysis, and to make them available so that they may be studied and improvements in technique applied. There is ample room for research in the field of laboratory evaluation, but fortunately for industry, metal cleaning as an art has kept in pace with developments in metal fabrication.

It should be emphasized that none of the methods described is recommended by Section G, but that this information was required before any attempt at cooperative effort could be made.

The evaluation of the methods follows this general outline:

Soil:
  Kind
  Application
    1. Preparation of Panels
    2. Method
    3. Aging Period
    4. Deviation
Cleaning Technique:
  Metals
    1. Kind
    2. Panel Size
  Solution
    1. Amount of Detergent
    2. Volume
    3. Temperature
    4. Time
    5. Agitation
    6. Replicates
  Method
  Rinsing
    1. Time
    2. Temperature
    3. Volume
    4. Agitation
    5. Method
    6. Test for Effectiveness
  Drying
    1. Temperature
    2. Time
Measurement of Soil Removal:
  Method
  Sensitivity

The information covered by this outline was not always available but has been made as complete as possible.

METHOD A—OIL REMOVAL

Method A-1

The method described by Morgan and Lankler (**156, 157**) follows:

Soil:

Kind.—Unspecified mineral oil composition used in rolling brass containing an unspecified amount of Fluorescent Oil Green H. W.

Application.

1. *Preparation of Panels.*—The metal test strips, 5 by 10 cm. (2 by 4 in.) in size are scrubbed by hand with a 0.50 per cent solution of Nacconol NR at 110 F., thoroughly rinsed in warm water, rinsed in alcohol, and allowed to dry.

2. *Method.*—Strips of wool flannel 4.7 by 9.7 cm. (1.875 by 3.875 in.) are saturated with a mineral oil composition such as is used in the rolling of brass. These oil-saturated wool strips are alternated with the metal strips to form a stack with protecting metal plates and oil-saturated wool strips above and below the stack of experimental strips.

The stack of plates is placed between the jaws of a hydraulic press, the edges of the stack of plates being carefully squared up. A pressure of 35 kg. per sq. cm. (500 psi.) is applied, and the pressure maintained until no more oil oozes out from the edge of the stack, the edges being constantly wiped with a clean cotton cloth. At the end of this process the pressure is released, and the strips are removed and retained in a perfectly horizontal position until taken out of the stack, one at a time, for the cleaning experiment.

3. *Aging Period.*—Not specified. Apparently to be used at once.

4. *Deviation.*—Average is 7.3 per cent by weight, present in 0.000113 g. per sq. cm., average for ten panels.

Cleaning Technique:

Metals.

1. *Kind.*

Steel: 20-gage cold-rolled sheet.
Galvanized steel: 20-gage, hot-dip-galvanized
Tin-plated steel: 24-gage dairy plate
Aluminum: Alloy 3S (1.2 per cent manganese), 20-gage, mirror finish
Brass: Soft brass sheet, 0.032 in. thick, Rockwell F hardness 61 to 62 annealed at about 550 C.

2. *Panel Size.*—2 by 4 in. (5 by 10 cm.).

Solution.

1. *Amount Detergent.*—0.5–10.0 per cent.
2. *Volume Solution.*—800 ml. in 1-liter beaker.
3. *Temperature.*—Variable.
4. *Time.*—Variable.
5. *Agitation.*—None.
6. *Replicates.*—Unspecified, but apparently single test.

Method.—The panels were fully immersed in the detergent solution, as in "soak" tank cleaning.

Rinsing.

1. *Time.*—1 min.
2. *Temperature.*—100 F.
3. *Volume.*—Unspecified. Running water.
4. *Agitation.*—Running water.
5. *Test for Effectiveness.*—None.

Drying.

1. *Temperature.*—Room.
2. *Time.*—Unspecified.

Measurement of Soil Removal:

Method.—Panels examined visually, or photographed under ultraviolet light.

Sensitivity.—Checked by gravimetric oil determinations. Minimum amount of oil detectable was 0.000004 g. per sq. cm.

Method A-2

The Nielco Laboratories method of evaluation follows:

Soil:

Kind.—S.A.E. 50 Lubricating oil (paraffin base).

Application.

1. *Preparation of Panels.*—None.
2. *Method.*—Immerse in S.A.E. 50 lubricating oil. Pennsylvania. Remove. Drain 1 hr.
3. *Aging Period.*—1 hr.
4. *Deviation.*—Not given.

Cleaning Technique:

Metals.

1. *Kind.*—Steel, aluminum.
2. *Panel size.*—2½ by 3 in.

Solution.

1. *Amount Detergent.*—0.9 to 3.3 per cent.
2. *Volume Solution.*—1000 ml.
3. *Temperature.*—Boil.
4. *Time.*—Variable.
5. *Agitation.*—None, other than boiling liquid.
6. *Replicates.*—Two, in same bath, held in unspecified manner relative to one another.

Method.—The panels were fully immersed in the detergent solution as in "soak" tank cleaning.

Rinsing.

1. *Time.*—Unspecified.
2. *Temperature.*—Cold.
3. *Volume.*—Unspecified; apparently from tap.
4. *Agitation.*—Unspecified; apparently from tap.
5. *Test for Effectiveness.*—Water break. See under separate "Rinsing Test."

Drying.

1. *Temperature.*—Unspecified.
2. *Time.*—Unspecified.

Measurement of Soil Removal:

Apparently by water break. Tests followed by plant trials.

Rinsing Test:

Glass panel 3½ by 5 in. dipped in the hot alkali cleaning solution for 5 min. Remove and rinse immediately in cold water. Allow to dry for 2 hr. Examine for any film left on panel. Add to panel 1 drop of alcohol and allow to evaporate. If no deposit is noted, compound is considered as free rinsing and the surface clean.

Method A-3

Rinker (243) evaluated metal cleaning compositions in the following manner:

Soil:

Kind.—Mineral oils 100 and 200 viscosity, mineral oil and 15 per cent fatty acid, mineral oil and 1.5 per cent and 5 per cent calcium soap, mineral oil and 10 per cent and 20 per cent sodium soap, sulfur-base mineral oil and protective lanolin film.

Application.

1. *Preparation.*—Anti-rust oil or surface film removed.
2. *Method.*—Panels dipped individually in the oils.
3. *Aging Period.*—Two weeks.

Cleaning Technique:

Metals.

1. *Kind.*—Cold-rolled steel.
2. *Panel Size.*—3 by 6 in.

Solution.

1. *Amount Detergent.*—6 oz. per gallon.
2. *Volume Solution.*—Sufficient for total immersion.
3. *Temperature.*—200 F.
4. *Time.*—3, 6, 9, 12, and 15 min.
5. *Agitation.*—Provided by heating at 200 F.
6. *Replicates.*—Several, but unspecified.

Method.—The panels were totally immersed in the cleaning solution as in "soak" tank cleaning.

Rinsing.

1. *Time.*—Not specified.
2. *Temperature.*—Not specified.
3. *Volume.*—Not specified.
4. *Agitation.*—Shower spray.
5. *Acid Dip.*—5 per cent sulfuric acid solution followed by further shower spray.

Drying.—Not indicated.

Measurement of Soil Removal:

Method.—Absence water break.

Method A-4

The Hercules Powder Co. method as described by Van Zile and coworkers which is a variation of the Morgan and Lankler method, is as follows:

Soil:

Kind.—100 viscosity Coastal Natural Mineral Oil (Sinclair Refining Co., Marcus Hook, Pa.).

Application.

1. *Preparation of Panels.*—Sheet steel (20-gage) strips 1 by 2 in. in size are dipped in carbon tetrachloride, sanded with waterproof Tri-M-ite paper (manufactured by Minnesota Mining and Manufacturing Co., St. Paul, Minn., designation 400-A-soft back), dipped in carbon tetrachloride, and dried in an oven at 80 C.
2. *Method.*—Strips of (80 by 80) cotton print cloth, ¾ by 1⅞ in. are saturated with the 100 viscosity oil, to which is added 1 g. of Fluorescent Oil Green HW 185 per cent to 100 cu. cm. of oil.

Balance of preparation as described by Morgan and Lankler.

Cleaning Technique:

Metals.

1. *Kind.*—Steel, 20-gage.
2. *Panel Size.*—1 by 2 in.

Solution.

1. *Amount Detergent.*—1 to 10 per cent.
2. *Volume Solution.*—125 ml. of solution in 150-ml. beaker.
3. *Temperature.*—80 C.
4. *Time.*—1 to 10 min.
5. *Agitation.*—None.
6. *Replicates.*—Apparently four are used.

Method.—Operated as a soak bath,[4] in which strips are hung from hooks.

Balance of method as described by Morgan and Lankler.

Rinsing.—In a stream of distilled water.

Drying.

1. *Temperature.*—80 C. in an oven.
2. *Time.*—Not specified.

Method A-5

Another Hercules Powder Company method (239) described in the 1942 edition of their pamphlet on "Dresinae" follows:

Soil:

Kind.—100 viscosity mid-continent oil.

Application.

1. *Preparation of Panels.*—Thoroughly cleaned.
2. *Method of Application.*—Soiled by squeezing a pile of alternated plates and oil-saturated cloths in a press at 1600 lb. per sq. in. pressure until no more oil is exuded.
3. *Aging Period.*—None.
4. *Deviation.*—Not given.

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[4] Constant temperature bath, 9 by 4½ by 6½ in., filled with water, equipped with an air stirrer at each end, and a rack for holding four 150-ml. beakers. A Variac is used to control the hot plate used to heat the bath and maintain the temperature constant.

Cleaning Technique:

Metals.

1. *Kind.*—Steel.
2. *Panel Size.*—2½ by 5½ in.

Solution.

1. *Amount Detergent.*—3 per cent.
2. *Volume Solution.*—1000 ml.
3. *Temperature.*—90 C.
4. *Time.*—Hot bath, 10 min.; electrolytic (anodic or cathodic), 5 min.
5. *Agitation.*—None.
6. *Replicates.*—One.

Method.—Operated as a "soak" bath in one case, or as an electrolytic bath in the other.

Rinsing.

1. *Time.*—Not specified.
2. *Temperature.*—60 C.
3. *Volume.*—Unspecified, from tap.
4. *Agitation.*—Tap water pressure.
5. *Test for Effectiveness.*—None.

Drying.

1. *Temperature.*—80 C.
2. *Time.*—Unspecified.

Measurement of Soil Removal:

Plates photographed under ultraviolet light, which causes any soil remaining on plates to fluoresce and is thus recorded.

Method A-6

A soap-silicate specification (**231**) utilizes a cleaning technique described essentially as follows:

Soil:

Kind.—Light mineral oil.

Application.

1. *Preparation of Panels.*—Not specified.
2. *Method.*—Pour 5 ml. of oil over both sides of panel.
3. *Aging Period.*—Allow to drain in vertical position for 5 min.

Cleaning Technique:

Metals.

1. *Kind.*—Aluminum.
2. *Panel Size.*—3 by 6 in.

Solution.

1. *Amount Detergent.*—As specified.
2. *Volume Solution.*—Completely immerse panel in properly diluted compound contained in a 2-liter beaker.
3. *Temperature.*—100 C.
4. *Time.*—10 min.
5. *Agitation.*—None.
6. *Replicates.*—One.

Method.—Operated as a "soak" bath.

Rinsing.

1. *Time.*—Not specified.
2. *Temperature.*—Not specified.
3. *Volume.*—Unspecified.
4. *Agitation.*—Dipping.

Drying.

1. *Temperature.*—Room temperature.
2. *Time.*—Not specified.

Measurement of Soil Removal:

Method.—Wash dried panel with 100 ml. petroleum ether, carefully collecting ether in a weighed evaporating dish. Evaporate ether on steam bath, then heat evaporating dish in oven at 100 to 105 C. for 15 min. Cool and weigh. Weight from residue must not be more than 1 mg. greater than residue from evaporation of 100 ml. of petroleum ether identical with that used in extraction. The evaporating dish must be cleaned and dried at 100 to 105 C., cooled and weighed to assure correct original weight.

Method A-7

Three specifications (**221, 225,** and **240**) have these characteristics:

Soil:

Kind.—S.A.E. No. 50 oil.

Application.—Coat panel with oil in unspecified manner. Aging period, if any, unspecified.

Cleaning Technique:

Metal.

1. *Kind.*—Anodized aluminum alloy.
2. *Panel Size.*—3 by 6 in.

Solution.

1. *Amount Detergent.*—Specified.
2. *Volume.*—Sufficient to permit immersion of plate.
3. *Temperature.*—Unspecified.
4. *Time.*—Time for oil removal is observed.
5. *Agitation.*—None.
6. *Replicates.*—One.

Rinsing and Drying.—Observed in another test.

Discussions

The soils used in these tests were mineral oil compositions used in brass rolling, S.A.E. 50 paraffin-base lube oil, 100 (mid-continent) and 200 viscosity mineral oils, light mineral oil, and mineral oil combined with fatty acid, calcium or sodium soap, sulfur-base mineral oil or lanolin.

In general, the removal methods were based on the "soak" tank, although one was operated as an electrolytic bath.

Methods of estimation of degree of soil removal in general were three: (1) the ultraviolet measurement of retention of an oil-soluble fluorescent dye, (2) petroleum ether washing of the cleaned panel for removal of retained oil, and (3) absence of waterbreak.

METHOD B—SOLVENT EMULSION

Method B-1

One specification (**230**) conforms to the outlined method as follows:

Soil:

Kind.—A lubricating oil of S.A.E. 70 viscosity is made into a paste with sufficient talcum powder.

Application.

1. *Preparation of Panels.*—Each panel is cleaned with a suitable solvent.
2. *Method.*—Spread the paste, starting at a distance of 2 in. down from a 3-in. edge over the hollowed side of each panel, until level. Each panel shall be baked in an air oven maintained at a temperature of 290 to 300 F. for 3 hr. Allow to cool to room temperature.
3. *Aging Period.*—Not specified. Apparently to be used at once.

Cleaning Technique:

Metals.

1. *Kind.*—Aluminum panels cut from corrugated aluminum (the corrugations shall be hollows with about 8 hollows to the inch and the depth of the hollows shall be about $\frac{1}{16}$ in.).
2. *Panel Size.*—3 by 6 in.

Solution.

1. *Amount Detergent.*—25 ml. of compound dissolved in 225 ml. kerosine.
2. *Volume Solution.*—250 ml.
3. *Temperature.*—70 to 90 F.
4. *Time.*—10 min.
5. *Agitation.*—None.
6. *Replicates.*—Apparently only one.

Method.—Suspend the panel with the 6-in. edge in the vertical position in 250 ml. of the prepared liquid. Allow to stand as indicated at the specified temperature. Remove and rinse as indicated.

Rinsing.—Flush each panel with a stream of water (water pressure shall be 30 to 40 lb. per sq. in. gage pressure, and nozzle of hose shall be a glass tube 3 in. long with $\frac{3}{8}$-in. inside diameter). The stream of water must be applied in a horizontal position at right angle to the panel surface and the surface shall be thoroughly flushed.

1. *Time.*—Not controlled.
2. *Temperature.*—Not given.
3. *Volume.*—Not controlled.
4. *Agitation.*—As indicated.
5. *Test for Effectiveness.*—Visual.

Drying.

1. *Temperature.*—Not given.
2. *Time.*—Not given.

Measurement of Soil Removal:

Method.—Visual examination of cleaned section compared with uncleaned portion. The cleaned section should show no more than extremely slight discolorations and no harmful detrimental action.

Method B-2

The following data were made available by Lowe of the Pennsylvania Salt Manufacturing Co., Philadelphia, Pa.

Soil:

Kind.

1. Paste of lubricating oil and talcum powder.
2. Dry carbon black of 28 millimicron average particle size (Binney and Smith).

3. Carbon black of B combined with a carbon tetrachloride solution of mineral or lubricating oil and solvent permitted to evaporate.

4. Any drawing or other compound under test.

Application.

1. Soil A is smeared over a corrugated aluminum panel and baked at 300 F. for 3 hr.

2. Ground glass is rubbed with the dry carbon black of soil B.

3. Soil C is smeared on ground glass.

4. Buffing and abrasive compounds are applied to cold-rolled steel panels from a buffing wheel; drawing compounds through action of suitable drawing dies; other compounds by smearing over cold-rolled steel surface with spatula and allowing time to set.

Cleaning Technique:

Metals.

1. *Kind.*—Glass, aluminum, cold-rolled steel, or other metal under consideration.

Solution.

1. *Amount Detergent.*

10 oz. per gal.—heavy duty cleaning
5 oz. per gal.—medium cleaning
½ oz. per gal.—light cleaning (and power washer application)
8 oz. per gal.—electrocleaning
Solvent emulsions: 1 part concentrate to 9 parts kerosine for dip-rinse application; 1 part of kerosine mix to 50 parts water for power washer.
Steam gun cleaning—½ oz. per gal.

2. *Volume.*—1 liter for preliminary evaluations. Where results are close, 10 gal. of solution in tank with steam heating coil to produce rolling boil is preferred. For power washer evaluation 40 gal. of solution are required for laboratory scale machine.

3. *Temperature.*—Rolling boil for heavy and medium duty cleaning; 180 F. for aluminum cleaning, power washer application, and electrolytic cleaning.

4. *Time.*—Varies with type of soil under investigation and technique employed; generally 5 min.

5. *Agitation.*—Rolling boil produces sufficient agitation where used. Air agitation is used at lower temperatures.

6. *Current* (electrocleaning), 50 amp. per sq. ft., anodic.

Method.—As indicated above.

Rinsing.

1. *Time.*—30 sec. in spray rinse; 1 min. in beaker or overflow tank rinse.

2. *Temperature.*—Spray rinse is used cold. Overflow tank rinse is cold. Beaker rinses are used at 190 F.

3. *Volume.*—Same volume as cleaner solution—3 successive rinses—for beaker testing. Ten-gallon overflow tank also used for cold rinsing.

4. *Agitation.*—Repeated up and down motion of work.

5. *Test for Effectiveness.*—See test below.

Drying.

1. *Temperature.*—Unspecified.
2. *Time.*—Unspecified

Measurement of Soil Removal:

The soil removal from specimens soiled and applied as in application 2 and application 3 is followed by photometric measurement of light transmittance.

The specimen of soil and application 4 is tested by plating the strip from an acid copper bath, under the following conditions:

Copper sulfate	27 oz. per gal.
Sulfuric acid	6.5 oz. per gal.
Temperature	70 to 90 F.
Current density	20 amp. per sq. ft.
Voltage	0.75 to 2.0 v.
Time	1 min.

Rinsing Test:

A 100-ml. sample is prepared at concentration of 4 oz. per gal. Add 0.5 g. ether purified carbon black. Mix for 1 min. in an electric mixer. Immerse a clean microscope slide in the mixture for 30 sec. Remove and place in a beaker of distilled water, permitting the water to rise slightly higher around the slide than when immersed in the cleaning solution. Let remain momentarily, transfer to a second and third beaker of distilled water, employing a similar technique. Allow slide to dry thoroughly, and examine surface for carbon residue. As an alternate method, 0.5 ml. mineral oil may be used together with 0.5 g. carbon black and 100 ml. of the solution to be tested.

Method B-3

The following data were developed from very tentative notes made available by Frazer of The Cowles Detergent Co.:

Soil:

Kind.

1. Benzol soot mixed by spatula with 100 viscosity (at 100 F.) straight run mineral oil.

2. One gram L. Martin and Co. Grade J extracted carbon black to 33 drops of 100 viscosity at 100 F. straight run mineral oil, ground together with a spatula.

Application.

1. *Preparation of panels.*—Cleaned by swabbing in trichloroethylene, followed by successive dip rinses in two more beakers of trichloroethylene.

2. *Method.*—Applied as a circular reference spot of about ¾-in. diameter at one end of plate at time of test.

Cleaning Technique:

Metals.

1. *Kind.*—Steel plates.
2. *Size.*—1½ by 6 in.

Solution.

1. *Amount Detergent.*—Unspecified.
2. *Volume.*—About 300 ml. in 400-ml. beaker.
3. *Temperature.*—Room.
4. *Time.*—1 min.
5. *Agitation.*—Soaked in emulsion.

Method.—Soak bath.

Rinsing.

1. *Time.*—About 5 sec.
2. *Temperature.*—About 120 F.
3. *Volume.*—Jet from a ¾-in. hot water tap.
4. *Agitation.*—Spray.

Drying.

1. *Temperature.*—Dried by own heat in air.

Measurement of Soil Removal:

Visual, and by wiping cleaned surface with white cheese cloth.

NOTE—Straight kerosine, a frequent component of cleaners of this type and considered as the reference (since its action alone should be improved by a proper cleaner formulation involving it), did not give complete removal of the carbon spot.

Discussion

The soil used in the evaluation of cleaners for the solvent emulsion method comprised lube oils mixed with talcum powder, carbon black, or benzol soot.

The methods of operation varied somewhat, but generally were of the "soak" tank type.

Considerable care is shown in several methods in designation of the method for rinsing.

Measurement of soil may be visual, visual by comparison with the uncleaned portion, photometric measurement of transmittance through glass, or by electrodeposition of a copper plate to a cleaned steel panel.

METHOD C—ELECTROLYTIC CLEANING

Method C-1

The electrocleaning technique described by Meyer (241) follows:

Soil:

Kind.

1. Commercial anhydrous lanolin.

2. Extreme pressure lubricant for heavy and deep drawing operations containing a chlorinated compound.

3. Pigmented drawing compound containing palm oil.

Application.

1. *Preparation of Panels.*

2. *Method.*—These soils were applied under pressure to steel panels and the panels then baked at 350 F. for 20 min.

Cleaning Technique:

Metals.

1. *Kind.*—Steel.

Solution.

1. *Amount Detergent.*—8 oz. per gal.
2. *Temperature.*—200 F.
3. *Time.*—Time recorded for cleaning.

Method.—Anodic or cathodic cleaning at a current density of 10 amp. per sq. ft.

Measurement of Soil Removal:

Absence of waterbreak.

METHOD C-2

The Hanson-Van Winkler-Munning Co. has developed a laboratory procedure useful for the evaluation of electrolytic metal cleaners.

They describe laboratory apparatus for the evaluation of either soak or electrified cleaners. The equipment provides for positive circulation (by pump) and an overflow bath. A titration method is recommended for determining the effective remaining alkali in the cleaning bath. Use of a laboratory centrifuge (to remove insoluble soil from the used cleaning bath), the control cleaning apparatus, and the titration analyses serve to decide the period at which the bath should be discarded. The apparatus is shown in Fig. 1.

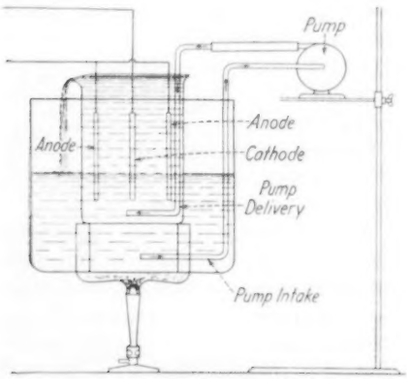

Fig. 1.—Laboratory Apparatus for the Evaluation of Cleaners

The effects of variation of current density, temperature, and concentration upon the cleaning rate of electric cleaning are illustrated.

DISCUSSION

Relatively few methods for the exclusive evaluation of electrolytic cleaners were found, but a laboratory set-up of interesting potentialities is described and, presumably, a variety of soils may thus be removed.

METHOD D—CARBON REMOVAL

METHOD D-1

The U. S. Naval Engineering Experiment Station (**126**) investigated a tenacious type of soil somewhat similar to that deposited on the surfaces of internal combustion engines. Duralumin panels were soiled by the following method, developed at the station:

1. Heat duralumin to near the softening point,
2. Plunge the specimen into a bath containing 1 per cent of Oildag in N. S. 1100 oil,
3. Burn off oil and bake residue at lower temperature, repeat several times, and
4. Allow the specimen to cool in the bath.

The above method produces a uniform soil which is impervious to ordinary soap and water. The efficiency of several cleansers was determined using this soil.

METHOD D-2

Another suggested soil is that described by Cosgrove (**90**).

A burnt spot of transformer oil was deposited upon a metal surface and measurement and comparison was made of the elapsed time to remove the spot.

METHOD D-3

A cleanser specification (**215**) has the following essentials:

Soil:

Kind.

Asphalt	2.5 per cent
Grade 120 aircraft engine oil	2.5 per cent
Kerosine	20.0 per cent
Xylene	65.0 per cent
Powdered rottenstone	10.0 per cent

Application.

1. *Preparation of Panels.*—Clean sheets well and remove any corrosion or stain by using a mild abrasive such as powdered rottenstone in a suitable liquid vehicle.
2. *Method.*—Coat one surface of each panel placed in a horizontal position with parallel strokes of a soft paint brush, using the previously well shaken soiling mixture. Bake each panel at 143 to 150 C. for 3 hr.
3. *Aging Period.*—Not specified.

Cleaning Technique:

Metal.

1. *Kind.*—Aluminum-coated aluminum alloy.
2. *Panel Size.*—About 2 by 2 in.

Solution.

1. *Amount Detergent.*—10 per cent aqueous solution in soft or softened water. 20 per cent kerosine solution. Prepare similar solutions with the standard sample.
2. *Volume Solution.*—Pour 50 ml. of each of the solutions on separate panels, each to be cleaned with a different solution.
3. *Temperature.*—Room.
4. *Time.*—2 min.
5. *Agitation.*—1 min. with a small stiff bristled brush.
6. *Replicates.*—One.

Method.—Spread the solutions uniformly over the panels with a brush without scrubbing. After 2 min., scrub all of panel with a small stiff bristled brush for 1 min.

Rinsing.

1. *Time.*—Unspecified.
2. *Temperature.*—Cold tap water.
3. *Volume.*—Unspecified.
4. *Agitation.*—Low pressure tap water at 45 deg. angle.

Drying.—Unspecified.

Measurement of Soil Removal:

Examine visually and compare for cleanliness, brightness and residue.

METHOD D-4

The removal of carbon from engine parts (**225, 226**) is effected by the following test:

Soil:

Kind and Method.—Carbonized piston from service engine.

Cleaning Technique:

Metals.

1. *Kind.*—Aluminum alloy.
2. *Size.*—One half or one fourth of piston.

Solution.

1. *Amount Detergent.*—Variable.
2. *Volume.*—Variable.
3. *Temperature.*—135 to 165 F. or other temperature specified.
4. *Time.*—4 hr.
5. *Agitation.*—None.
6. *Replicates.*—One.

Method.—Sections of the same piston are immersed in a solution of standard compound and a solution of test compound.

Rinsing.—In one case (**226**) no rinsing is given but the piston is wiped at hourly invervals with a cloth, while in the other, water or trichloroethylene and a stiff bristled brush are used.

Drying.—None.

Measurement of Soil Removal:

Visual comparisons between results with test and standard solutions are made for degree of carbon removal.

DISCUSSION

The soil encountered in this type of cleaning is probably more tenacious than others because of method of deposition and attempt to simulate carbon deposition in internal combustion engines. Consequently, some degree of mechanical force may generally be applied to the surface to be cleansed.

The method for evaluation of results is direct comparison with an untreated panel or one which has been cleaned in a composition of known characteristics. Although corrosion induced by the cleaning compositions may be a controlling factor in choice of detergent, this has been considered under the subject of corrosion tests.

METHOD E—FRICTION REMOVAL

The term "friction removal" may be used to cover mechanical, manual, brush, or spray methods for soil removal. This type of soil removal has been segregated from the others simply because of the

method used for evaluating the surface cleaners. Although one method described is applied to the removal of soil from a painted panel, the technique involved might readily be applied to soil removal from strictly metallic surfaces.

METHOD E-1

A standard soil and method for removal has been the subject of a Navy Aeronautical specification (242):

Soil:

Kind.—Light mineral oil and Norit A, C, or S.A.U.-30.

Application.

1. *Preparation of Panels.*—Aluminum alloy panels are anodized according to specification, then finished with a specified primer, lacquer and finish coat in scheduled time.

2. *Method.*—Place 1 drop of light mineral oil on prepared panel and spread oil evenly with tip of one finger over this face of the panel. Sift onto the oiled panel face Norit A, C, or S.A.U.-30, using a small cheesecloth bag until the plate is evenly covered. The plate is then turned over and tapped to remove excess carbon.

3. *Aging Period.*—Not specified.

Cleaning Technique:

Metals.

1. *Kind.*—Aluminum alloy panel 0.051 in. anodized according to specification.

2. *Panel Size.*—3 by 6 in. with corners and edges smoothed.

Solution.

1. *Amount Detergent.*—Preparation diluted 1:25.

2. *Volume Solution.*—5 ml.

3. *Temperature.*—Room.

Method.—Pour and spread 5 ml. of 1:25 dilution onto soiled plate. The panel is then flooded with the 1:25 solution and gently brushed with a test tube brush, flushed with 1:25 solution once, rinsed by pouring 500 ml. of water over the panel. All soil and oil should be removed by this process.

Rinsing.

1. *Volume.*—500 ml. of water poured over panel.

2. *Temperature.*—Room.

3. *Agitation.*—None.

Drying.—Not specified.

Measurement of Soil Removal:

Method.—Observe for visual evidence of an oil film, soap film or iridescence. Results shall be equal to or better than those obtained with a standard composition.

METHOD E-2

The evaluation of paint cleaners (234) may be made to conform to the outline as follows:

Soil:

Kind.

Metallic brown (Navy Dept. Specification 52B1)	20 g.
Kerosine (Navy Dept. Specification 14K1)	20 g.
Carbon tetrachloride (Navy Dept. Specification 51C34)	20 g.
Heavy white mineral oil (or Nujol) (U.S.P.)	1 g.
Forced feed lubricating oil, Navy Symbol 3120 (WBS 431)	1 g.
Hydrogenated vegetable shortening (Federal Specification EE-L-101)	1 g.

Application.

1. *Preparation of Panels.*—The panels shall be initially prepared by applying in the following order: One coat each of paints conforming to the requirements of Navy Dept. Specifications 52P18, 52P22, and 52P21. A drying time of 2 weeks between coats and a minimum drying time of 1 month after application of the final coat shall be allowed. When tests are to be made, panels prepared as specified above or panels previously used for tests shall be lightly sanded to roughen the paint surface, remove any loose paint, and improve adhesion of the subsequent coat. One coat of paint conforming to the requirements of Navy Dept. Specification 52P21 shall then be applied and allowed to dry for 4 days.

2. *Method.*—The panels which have been dried 4 days are laid flat, and are evenly soiled by brush, using the well-shaken soil given above. The panels are then baked in a horizontal position in a circulating oven at 100 to 105 C. for 30 min.

3. *Aging Period.*—The baked panels shall be used within 24 hr. after soiling.

Cleaning Technique:

Surface.

1. *Kind.*—Steel coated as under application 2.

2. *Panel Size.*—3 by 10 by $^1/_{16}$ in.

Solution.

1. *Amount Detergent.*—50 g. per liter.

2. *Volume Solution.*—87 ml.

3. *Temperature.*—Room.

4. *Time.*—Dependent upon washer apparatus.

5. *Replicates.*—Two.

Method.—Prepare 1 liter each of a trisodium phosphate (U.S.P.) solution and a solution of the compound under test at concentrations of 2 g. per liter in distilled water. Measure the specular gloss of two panels and immerse one panel in each of these solutions, kept at room temperature, for 1 hr. Remove the panels, rinse thoroughly in distilled water, and dry at room temperature. Again measure the specular gloss of each panel. The percentage decrease in gloss of the portion of the panel immersed, compared with the gloss of the same panel before immersion shall be reported for the compound under test and for the trisodium phosphate.

Rinsing.—Rinse well in tap water at room temperature.

Drying.—Dry at room temperature.

Measurement of Soil Removal:

Method.

Reflectometer.—A photoelectric instrument shall be employed for measuring the apparent reflectances of test panels. It shall be calibrated and used in a manner such as to give results as percentage reflectance, relative to magnesium oxide, for conditions of 45-deg. illumination and normal viewing. The instrument shall be of a design such that measurements obtained by its use closely approximate those obtainable through the use of I.C.I. Illuminant C and Standard Observer.

Washability Apparatus.—The apparatus to be used in washing soiled painted panels with a solution of the compound to determine cleaning efficiency shall be equivalent to the apparatus illustrated by Figs. 2 and 3. This apparatus shall consist of a wooden baseboard covered with tinplate, at one edge of which is mounted a heavy duty air-pressure operated windshield wiper. The wiper arm shall extend part way across the base plate and to its end shall be soldered a brass box to serve as a receptacle for a cellulose sponge. The sponge shall be cut to dimensions of $4\frac{1}{4}$ by $1\frac{3}{4}$ by $2\frac{3}{4}$ in. dry, or 5 by 3 by $2\frac{3}{4}$ in. wet. The weight of the box plus dry sponge shall be adjusted to 1 lb., 11 oz., by means of lead washers placed on pins at the corners of the box, and the spring in the wiper arm disconnected to avoid extra pressure. In operation, a soiled painted panel shall be held by stops at the center of stroke of the wiper arm and the number of strokes recorded on an automatic counter. It is not absolutely essential that the sponge box (and sponge) be moved by a windshield wiper as good results can be obtained by moving the sponge box back and forth in the same manner by hand.

Procedure.—Measure the reflectance of a painted panel prepared as specified and soil the panel as specified. Place the soiled panel in the space in the base plate of the washability apparatus and pour over it 50 ml. of a distilled water solution containing 50 g. of compound per liter of solution. Allow the panel to soak 1 min. and in the meantime pour 24 ml. of the same solution over the cellulose sponge and insert this in the box attached to the wiper arm. Start the wiper at the rate of 1 stroke ($\frac{1}{2}$ cycle) per second and allow to continue for 100 strokes (50 cycles). Allow the same detergent solution to drip on the panel from a burette at such a rate that approximately 12 ml. are delivered during the 100-stroke period. Remove the panel and sponge, rinse the panel, and squeeze out the sponge in cold tap water. Replace the panel in the space provided for it, but reversed end for end from its previous position. Repeat all the previous cleaning steps but omit the addition of 50 ml. of solution to the panel. Remove the panel, rinse well with tap water, and dry at room temperature. Again measure the reflectance of the panel. Make duplicate determinations of the cleaning efficiency at 50 g. per liter concentration in distilled water and duplicate determinations in synthetic sea water.

Measure reflectance of the painted panel prior to soiling, then repeat the reflectance measurement after the washing process.

Calculate cleaning efficiency by the following formula:

$$\text{Per cent Cleaning Efficiency} = \frac{R_2}{R_1} \times 100$$

where

R_1 = Reflectance of unsoiled, unwashed painted panel, and

R_2 = Reflectance of soiled, washed painted panel.

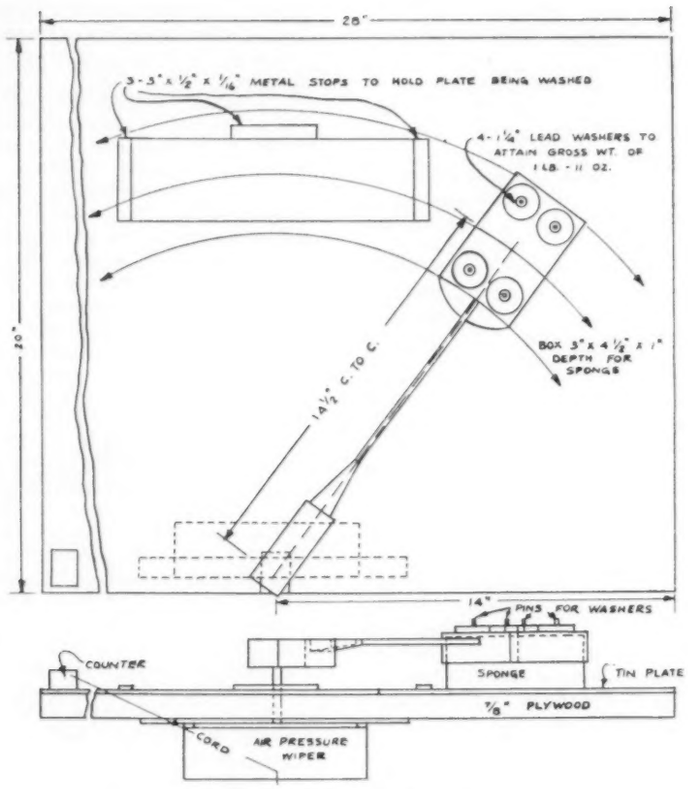
28"
3 - 3" x ½" x 1/16" METAL STOPS TO HOLD PLATE BEING WASHED
4 - 1¼" LEAD WASHERS TO ATTAIN GROSS WT. OF 1 LB. - 11 OZ.
20"
BOX 3" x 4½" x 1" DEPTH FOR SPONGE
14½" C. TO C.
14"
PINS FOR WASHERS
COUNTER
SPONGE
TIN PLATE
⅞" PLYWOOD
CORD
AIR PRESSURE WIPER

Fig. 2.—Washability Apparatus.

METHOD F—PAINT STRIPPING

Although paint stripping may not usually be considered as metal cleaning, the fact that there is a demand for such products, secured under specification, is indication that there is a demand for materials to produce this effect. The technique used in evaluation of such products falls into the metal cleaning category.

Method F-1

Several specifications **(220, 221, 223, 240)** have been developed for the evaluation of paint strippers. Their essential characteristics have been condensed to the standard form.

Soil:

Kind.—Primer of zinc chromate and two enamel coats of varnish, cellulose nitrate or high resin phthalate lacquer, glyceryl phthalate enamel, or black glyceryl phthalate.

Application.

1. *Preparation of Panels.*—Anodized.
2. *Method.*—Primer is sprayed onto one side and dried 1 hr. before next coat. Varnish, enamel or lacquer is then applied according to schedule with definite time periods between coats and before baking, as well as definite baking periods and temperatures.
3. *Aging Period.*—Not specified. Apparently used at once.

Cleaning Technique:

Metals.

1. *Kind.*—Aluminum-alloy sheet coveredwith chromic-acid type anodic film.
2. *Panel Size.*—3 by 6 in. by 0.051 in. properly numbered.

Solution.

1. *Amount Detergent.*—Not given.
2. *Volume.*—Complete immersion or brushed onto surface being stripped.
3. *Temperature.*—Room, or specified.
4. *Time.*—If brushed on, 5-min. intervals between applications, or if immersed, the time for removal is observed by stroking with a soft bristle brush.
5. *Agitation.*—As indicated under "Time."
6. *Replicates.*—Apparently one.

Method.—Solution 2 and solution 4.

Rinsing.

1. *Water.*
   (*a*) *Time.*—Indefinite to 5 min.
   (*b*) *Temperature.*—77 to 185 F.
   (*c*) *Volume.*—Unspecified.
   (*d*) *Agitation.*—Unspecified.
2. *Trichloroethylene.*
   (*a*) *Time.*—Few seconds.
   (*b*) *Temperature.*—Room.
   (*c*) *Volume.*—Unspecified.
   (*d*) *Agitation.*—Unspecified.
   (*e*) *Drying.*—Room temperature.

Measurement of Soil Removal:

Method.—Visual, for corrosive attack, oxidation, discoloration, and presence of stripping solution.

Discussion of Soil

It is evident from the variety of soils described, and their method of

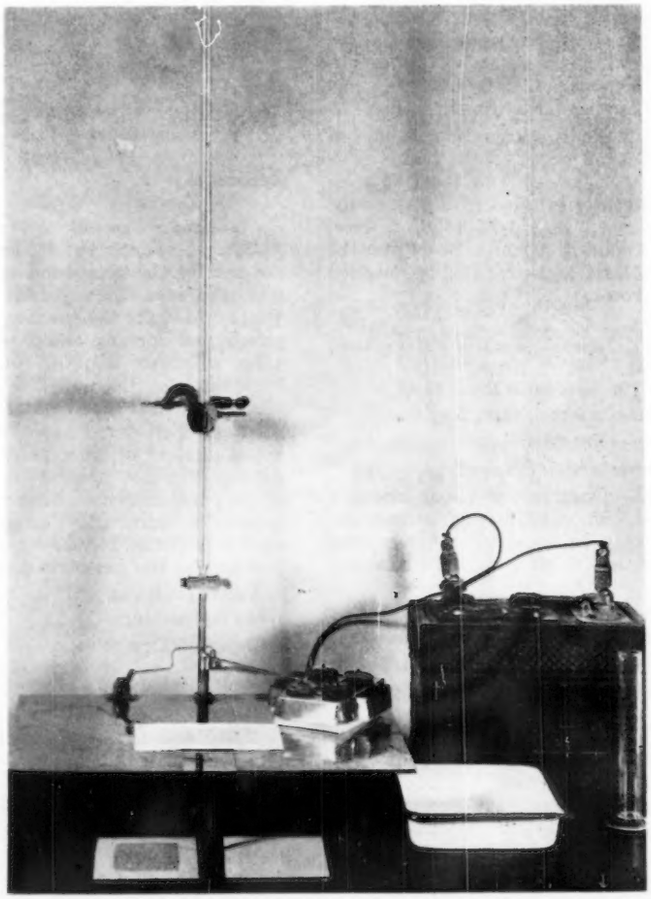

Fig. 3.—Washability Apparatus.

preparation, that a single soil will not cover all the possible conditions encountered, nor is this necessary. A lightly adherent soil will yield to less drastic treatment than tenacious soils, and the composition of the basis metal will influence the choice of both cleansing agents and methods of operation.

A number of investigators have carefully considered the method of soil application but not all have reported upon the reproducibility of their soils. It is presumed that the panels are free from contaminants prior to application of the soil, or that this has no bearing upon results, but several methods rightly contain definite directions in this respect.

In the interest of improved reproducibility, definite directions should be given for the preparation of the panel prior to soil application, even though this may seem superfluous. Specific, clear directions should be given for the preparation and application of the soil to the panel surface, and pertinent variables should be under full control. The age of the soil may have marked bearing upon ease of removal, and several methods contain a specification to control this factor, so that directions should be given to avert possibility of error from this source.

Discussion of Cleaning Technique

Control of the factors involved in cleaning technique has marked effect upon the reproducibility of the method. Presumably, the cleaning method (soak tank, etc.) is conducted either under arbitrary conditions or ones which attempt to reproduce plant conditions.

Few of the tests indicated the number of replicate tests which were necessary to substantiate findings, perhaps because of insensitiveness of the means for measuring the degree of soil removal.

The ease of removal of cleaning composition contaminated by soil is an important factor and several tests for rinsing effectiveness have been developed. It is obvious that a detergent must not only assist in removing soil from a given surface, but must retain the soil in suspension so that the surface is not recontaminated upon withdrawal from the cleaner bath, or upon rinsing.

Discussion of Measurement of Soil Removal

One of the most difficult features of the actual cleaning test is determination of degree of effectiveness of soil removal. The test most often used, under the theory that a clean surface will be uniformly wetted by water, is the time-honored "waterbreak" method. The absence of "waterbreak" is taken as indication of absence of oily, water-repellent contaminant. Recently developed information indicates that preferential adsorption can take place at metal or other surfaces, and that this could take place with metals presenting a presumably "clean" surface because the adsorbed coating is "hydrophilic" or the opposite of water-repellent. The presence of such a film, however, might not be desirable at a subsequent step in the manufacturing operation. Consequently, a more specific and sensitive test is desirable.

One of the most recent advances in measurement of soil retention is that of Morgan and Lankler who utilized a fluorescent dye, ultraviolet light, and photography. The sensitivity of the method was checked gravimetrically and the minimum amount of oil detectable (containing the fluorescent dye) was 0.000004 g. per sq. cm. of metal surface. The application of photometric measurement to this technique would provide more rapid and valuable data.

Photometric means for measurement of reflectance are used in one method in which partial or total removal of soil is effected. The advantage to photometric measurements is obvious since comparisons automatically become numerical.

Summary

None of the methods described is recommended by Section G, since the object of this paper is to present all available methods and to evaluate them according to an "ideal" outline. It is expected that the data thus developed will aid materially in subsequent Section work.

The varieties of soils which may potentially contaminate metal are many, and the possible methods which may be utilized in removal of such soils are likewise varied. It is not unusual, therefore, that published methods for laboratory evaluation of soil removal are numerous and that techniques are also varied.

No attempt is made either to dictate which soil shall be used, nor the method of removal, but factors which may be variable should be recorded and greater attention paid to attempts to improve the degree of reproducibility. To this end, a general outline is given covering the preparation and application of the soil, the cleaning technique, and the measurement of degree of soil removal. Only recently have efforts been made to utilize other than visual or gravimetric methods for estimation of degree of soil removal, both of which are lacking in sensitivity. Recently developed methods use either photometric measurement of soil removal or photographic measurement of fluorescence produced by dye present in oil which contaminates a metal surface.

Evaluation of seventeen methods for measurement of soil removal indicates the need for closer control of all factors involved in the evaluation method. This will be particularly true with the development of more accurate and sensitive methods which can be used for evaluation of the cleaned surface.

Acknowledgment:

The suggestions made by Section G members R. B. Mears, Aluminum Corporation of America, and William Stericker, Philadelphia Quartz Co., have been of material assistance to me in the preparation of this paper.

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Some Factors in the Interpretation of Small-Scale Tests for Fire-Retardant Wood

By F. W. Gottschalk[1]

THIS paper is based upon a number of observations that were made in the research and plant-control laboratory during the production of over 50,000,000 board feet of fire-retardant vacuum-pressure treated wood. The methods of testing included the special-crib test as described in A.S.T.M. Tentative Method of Test for Fire-Retardant Properties of Wood (C 160 – 41 T)[2] and the fire-tube test. These two methods of determining the fire-retardance of chemically processed lumber permit a great variety of data to be obtained, such as the final loss in weight, duration of after-flame, duration of after-glow, maximum temperature developed during test, area under the time-temperature curve and maximum rate of weight loss.

Final Loss in Weight

The most consistent and readily established value is the final weight loss. The percentage of final weight loss is commonly used for plant control, while the many other data usually serve in the field of basic research. Duration of after-flame and after-glow has been used on occasion, but the exact end point of minute flame or glow is difficult to establish, so these determinations are of limited practical value in plant control work. Regardless of whether after-flame and after-glow are recorded, the effects of either are to consume the test specimen, which, in any event, is fully reflected as final weight loss.

The loss in weight is determined by weighing the properly conditioned specimen before the test and then weighing the specimen as soon as all after-flame and after-glow have ceased.

A typical specimen of southern pine or Douglas fir before test weighs approximately 110 g. for the fire-tube test and 180 g. for the special-crib test. Untreated wood will usually have a final weight loss of 75 per cent or more, and well-treated wood, with considerable fire-retardance, will usually have a final weight loss of 30 per cent or less, when subjected to either test. But technicians have been confronted with a variation in results for what appears to be matched material when using these tests. Although the average final weight-loss data are fairly consistent for the fire-tube or special-crib tests, it is difficult to reproduce results to very close limits when testing several specimens obtained from similar wood. In the present paper an attempt will be made to outline reasons for these differences in the test results.

Factors Influencing Test Results

Two factors have been observed that can cause the spread between maximum and minimum percentages of final weight loss. One is variation of results which are normal characteristics of the apparatus and the other is a nonuniformity of the sample providing the specimen. These factors are made clear by the 1941 Report of Committee C-5 (Tables II and IX)[3] and by the 1944 Report of Committee 9 on Fireproofing of the American Wood-Preservers' Association.[4] The data for the fire-tube method and the special-crib method show the widest variation for the percentage of final weight loss when the material under test contains retentions of fire-retardant chemical in the range of 2 to 4 lb. per cu. ft. of wood. This is of interest to wood technologists because the tests are used for lumber containing approximately 3 lb. of chemical per cu. ft. of wood, the grade M (Moderate) fire-treatment range in several specifications. Some specifications, using these test methods, require "pin-point" results and technicians are often confused when they obtain results which show considerable variation. Retentions of less than 1 lb. and the grade H (High) fire-retardance with retention of approximately 5 lb. or over of chemical per cu. ft. show less variation than the grade M range. However, a spread between maximum and minimum results for the untreated wood and the grade H range is considerable, even with wood of the same species.

The first factor, characteristic of the apparatus, has been analyzed by statistical methods by A.S.T.M. Committee C-5 on Fire Tests of Materials and Construction. In terms of percentage of weight loss, selected southern pine retaining 3.20 to 3.33 lb. of fire-retardant chemical per cu. ft. of wood had a maximum weight loss of 34.0 per cent with the fire-tube and 66.0 per cent with the special crib. But the minimum weight loss for the tube was 19 per cent, with a range of 15 per cent, while for the crib the minimum weight loss was 26 per cent, with a range of 40 per cent. Some of this deviation with similar material containing 3 lb. of fire retardant is, apparently, a normal characteristic of the apparatus and testing procedure as all reported test results show the same type of variation in this retention range.

The second factor, variation in material tested, probably accounts for much of the weight-loss differences. For example, untreated southern pine had from 77.5 to 94.0 per cent final weight loss, while matched pine retaining 5.51 to 5.99 lb. of fire-retardant chemical had a maximum weight loss of 27 per cent for either test, the minimum (13.5 per cent) for the tube was 13.5 per cent less than the maximum, and the minimum (20.0 per cent) for the crib was 7 per cent less than the maximum. Andrews[5] and others have shown that five carefully conducted tests of material cut from a

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to A.S.T.M. Headquarters, 260 S. Broad St., Philadelphia 2, Pa.

[1] Technical Director, American Lumber and Treating Co., Chicago, Ill.

[2] 1944 Book of A.S.T.M. Standards, Part II, p. 1259.

[3] Report of Committee C-5 on Fire Tests of Materials and Construction, *Proceedings*, Am. Soc. Testing Mats., Vol. 41, p. 238 (1941).

[4] Report of Committee 9 on Fireproofing, *Proceedings*, Am. Wood-Preservers' Assn., Vol. 40 (1944).

[5] L. K. Andrews, "A Study of Fireproofing Standards for Pressure-Treated Lumber," *Proceedings*, Am. Wood-Preservers' Assn., Vol. 38, pp. 462–481 (1942).

single board will give similar variations. It appears that the variation between specimens cut from untreated and well-fireproofed wood is due partly to variations in the wood itself. Wood is not a homogeneous substance. When interpreting small-scale fire tests, account should be taken of moisture content, size, density, distribution of fire-retardant chemicals, as well as resin content of the specimen.

The weight of wood sawn carefully to identical dimensions is not the same for different pieces. Moisture content, density, and chemical content of the lumber all are responsible for variations in weight. For example, a specimen at 10 per cent moisture content, of dense wood, and with 12 lb. of chemical per cu. ft., will weigh much more than a specimen at 4 per cent moisture content, of low-density wood, and with 6 lb. of chemical. Yet either specimen could be selected as a representative sample from a retort charge after treatment. For treated wood, containing about 5 to 6 lb. of chemical per cu. ft., the final weight-loss values are usually 20 to 30 g. in the fire tube and 32 to 42 g. in the special crib. Material from the same board usually shows a variation of only 3 or 4 g. in final weight loss, even when the original weights of the specimens are quite different. Perhaps additional study should be given to the relationship of total weight loss and percentage of weight loss, for it would seem that light specimens will have a greater weight loss in per cent than heavy specimens. By examining the variations for wood based upon extremes that can be found, one can establish the reasons why test results are difficult to duplicate.

Moisture content at time of test is specified as 7 ± 3 per cent, which is as accurate as the expedient methods of conditioning wood permit. This allows a range from 4 to 10 per cent, which at first glance does not appear significant. While there is no evidence to indicate that any variation within this moisture-content range will increase or decrease the degree of burning of the specimens, the difference in weight of the wood affects the percentage calculations. It is evident that this moisture factor could cause a variation from 107 to 113 g. in the weight for the average tube specimen and 175 to 185 g. for the average crib specimen.

The dimensions of the specimen are commonly defined for the fire-tube test as $\frac{3}{8}$ by $\frac{3}{4}$ in. in cross section and total length of 40 in., with a tolerance of $\pm \frac{1}{32}$ in. on cross section and $\pm \frac{1}{4}$ in. on length; and for the special-crib test, 24 pieces $\frac{1}{2}$ by $\frac{1}{2}$ in. in cross section and 3 in. in length, with a tolerance of $\pm \frac{1}{32}$ in. in any dimension. These measurements are as close as the normal procedures of sawing will permit. In most cases for plant control, the specimens are sawn in the wet condition, and subsequent drying to approximately 7 per cent moisture content causes some shrinkage. The tolerances permit considerable volume differences. For the fire-tube specimen, the minimum volume is 161 cu. cm. and the maximum volume is 209 cu. cm.; for the special-crib specimen the volumes are 257 cu. cm. and 336 cu. cm. These represent over 20 per cent difference in volume. The size tolerance, expressed as weight, is an especially important factor when linked with the variations in density.

The density of the wood is the most important single factor affecting the weight of specimens. For example, southern pine and Douglas fir, the principal structural woods, can have specific gravity from 0.22 to over 0.65 (based on oven-dry weight and green volume). This is particularly significant. A fire-tube specimen of untreated wood, of minimum size and density, will weigh approximately 35 g., while a specimen of maximum size and density will weigh approximately 136 g. For the special crib, the same specimens will weigh 57 g. and 218 g., respectively. As has been pointed out, the mechanics of calculating percentage loss in weight, based on the initial weight of the specimen, make such variations a source of different results.

In addition, the retention of fire-retardant chemical will add weight to the specimen. For nominal 1-in. boards, the retention of 5 lb. can be accomplished by means of an 11 per cent concentration of treating solution, but for slightly higher retentions and with large timber sizes, a 25 to 30 per cent concentration may be used. In the outer treated zones of the penetration-resistant heartwood of timbers of fir, for example, a concentration of 30 per cent may leave retentions of 12 to 15 lb. of chemical in the penetrated area. Subsequent drying may cause a diffusion of the chemical toward the wood surface or toward the interior, so that face-cut test specimens may actually have more or less chemical than the average of the piece or charge. The retention of 5 lb. of fire-retardant per cu. ft. of wood will add 20 g. for a crib specimen of the minimum size, while a retention of 15 lb. of fire-retardant per cu. ft. will add 81 g. for a crib specimen of the maximum size. The low density crib specimen with 5 lb. of chemical per cu. ft. can weigh as little as 77 g., while the high density specimen with 15 lb. of chemical can weigh as much as 299 g. All factors causing variations in the initial weight of the test specimen may, in turn, affect final weight loss calculations. Certain specifications limit final weight loss to a maximum of 25 per cent; the lighter specimen can lose 20 g. in the test and fail while the heavier specimen can lose as high as 74 g. and be accepted under the specification.

Resin, which is present in most softwoods, is another cause of variation. Heartwood usually contains more resin than sapwood. Although the resin may increase the weight of the specimen to various degrees, its influence probably is to increase the flaming of the wood. Inasmuch as it is not customary to establish the resin content of wood, its effect upon the fire-tube and special-crib tests is still unknown.

Conclusions

Closer tolerances for moisture and size do not appear practical from an operational viewpoint. Density is an indefinite characteristic since boards cut from the same tree do not have the same specific gravity. There is no practicable method to determine the density of a charge or order of material and there is no quick method to determine the density of a sample; hence, the only solution is to recognize these characteristics of wood when preparing specifications, utilizing the fire-tube and special-crib tests so that samples of low moisture content of the minimum size and low specific gravity will be acceptable. Additional study of these subjects should be made.

Discussion of Paper on Structural Tests on Ships*

MR. J. VASTA[1] (*by letter*).—Lord Kelvin has been credited with saying that "the essential in studying any phenomenon is to make measurements." This is true in every engineering field; the ship structure is no exception. To study the reaction of a ship structure under a known applied load, it is essential to measure strains at chosen locations and compare these with theoretical values. In doing this, the electric resistance strain gage plays an important role. Because of its relatively small size and weight, it possesses a flexibility which cannot be obtained with mechanical gages. Moreover, its short base length plus its ability to send its report over a small pair of wires to a distant point makes it especially useful for measuring strains at otherwise inaccessible locations.

Credit for being the first to use the SR-4 electrical resistance gages for ship structure investigation probably belongs to the U. S. Maritime Commission. In the summer of 1941, a series of full-scale tests on a reinforced-concrete hull was conducted to obtain information on the basic assumptions that governed the structural design of such vessels. The many precautions that the author of the paper points out so lucidly were taken. However, field conditions, particularly the excessive moisture in the test tank where strains were sought, prevented the setting of the cement, hence the electrical gages could not be made to adhere to the reinforcing bars of the structural element under test. It is gratifying to note that these early difficulties have now been largely eliminated by a combination of improved technique and improved cementing materials. Incidentally, this test was carried forward by the use of mechanical strain gages.

Although these early trials gave a somewhat negative result, faith in the electric resistance gage was not dimmed. The Maritime Commission planned a comprehensive test on a steel vessel of the Liberty type wherein much of the experience of previous investigators was pooled to insure a successful test. The Liberty ship was tested during the summer of 1944 and required a period of approximately six weeks. Well over 11,000 electrical strain gage readings were taken during this period and a relatively small percentage of readings was lost. This speaks favorably for the technique and care exercised in preparing the strain gage stations and in protecting them against moisture and physical damage from the traffic of the testing personnel. The result of this field experimentation bears out the faith in the electrical gage as a reliable measuring instrument when applied to the structure with all the precautions that the author describes in his paper.

The question of drift, or lack of gage stability, is one that will always cause some concern. The cause should be sought. Future technological developments of the bonding material used to attach the gage to the structure may eliminate this annoying deficiency. Public enemy No. 1, as far as the electrical gage is concerned, is the moisture present in the atmosphere surrounding the test specimen. Properly cemented gages on tests performed under ideal conditions in the laboratories show negligible drift for such periods of time as are usually considered ample for the completion of the experimental investigation. The situation in the field is usually entirely different and the success of the enterprise depends on the care exercised and technique employed in attaching and protecting the gages. In the Liberty ship test referred to above, all the gages were left on the structure for a period of approximately four weeks. Strains measured at the completion of the loading cycle did not, in the main, check absolutely the zero strains measured at the beginning of the test. If this lack of agreement between the two zero readings—taken at the initial and final stages of the tests—can be ascribed solely to the phenomenon of drift and to no other cause, then there is evidence that all except a few of the strain gages drifted. The average drift for the entire group was about 75 micro-inches, which corresponds roughly to 2000-psi. stress. Stresses induced by loading were of the order of 25,000 psi. The accuracy of the data, however, was much closer than the amount indicated by the drift, because, in many instances, while one gage element on the top face of the plate would show an apparent elongation, the opposite gage element on the other face of the plate would show some contraction, thereby tending to neutralize the effect mentioned. It is believed that this phenomenon of drift results from some minute plastic deformations that take place in the cement itself. It is hoped that future technical developments in this direction will eliminate such difficulties experienced in the field.

The state of stress at any one point on the structure can be computed from strains measured in three different directions. This requires that the electrical gage have a minimum of three elements. A strain gage station on a plate must consist of two such "rosettes," one on each face of the plate—a total of six wire elements. The strains measured on each pair of elements must be averaged to obtain the strain in their direction at the middle plane of the plate. Strains measured on only one face of the plate will involve large errors, certainly much larger than those the author describes in his paper. In some instances, on the structural tests of the Liberty ship, the difference between top and bottom strains on any one particular pair of elements was as much as 100 per cent, meaning, thereby, that the plating to which the gage was attached had an appreciable bending stress and a curvature which was not visible to the eye. The experience gained in testing about a dozen steel ships indicates definitely that strains measured on one face of the plate alone will lead to deceiving and inaccurate conclusions. Rational comparisons between measurements and theory are destroyed if the experimenter measures strains on only one face of the plate without some

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* W. V. Bassett, "Practical Electric Resistance Strain Gage Procedures for Structural Tests on Ships," ASTM BULLETIN No. 134, May, 1945.

[1] Assistant Chief Research Section, United States Maritime Commission, Washington, D. C.

means of evaluating the strains resulting from changes in plate curvature.

When a large structure, such as a ship, is tested, it is almost impossible to eliminate the thermal effects resulting from changes in temperature. It is impossible to expect the "dummy" gage to do this because the restraint of the structure to temperature variations has been found to be different on all three axes of the gage elements. Therefore, even if it were possible to obtain an accurate record of the temperature changes in the plating to which the gage is attached, a preknowledge of the effect of restraint would be necessary in order to correct the strain for the temperature effect. An attempt at eliminating this difficulty consists of taking strain readings during the night, hoping that the air temperature surrounding the structure has stabilized itself and will be the same as during previous readings. It is impossible, of course, to control temperature fluctuations from night to night. However, these fluctuations will be of a small order, and their influence on the accuracy of the data not significant. Nevertheless, the precaution should be taken to select "dummy" gages and acting gages from the same box, and similarly, if possible, the indicating instruments ought to be kept within one room at a reasonably constant temperature.

The interest shown by the various shipbuilding organizations toward solving, by a systematic program of research, the many problems related to welding procedure and its effects, is a commendable one. It is only through such systematic approach that the experimental facts can be determined. In this endeavor, a knowledge of the limitations of the gage and its idiosyncrasies will go a long way toward lending weight to the experimental findings. The author of this paper is to be congratulated for bringing up to date the many pertinent points considered essential in the application of the electrical gage to structural investigations.

MR. W. V. BASSETT[2] (*author's closure by letter*).—Mr. Vasta's comments on some of the first applications of resistance strain gages to ship structures are appreciated. His emphasis on the necessity for control of moisture effects and gage instability or drift, and on the use of gages on both surfaces of a plate is decidedly worth while.

In connection with Mr. Vasta's statements on thermal stresses and restraint, a brief description of a test recently conducted by the Development and Research Branch of the Bethlehem Steel Co., Shipbuilding Division, may be of interest. Temperatures and changes in longitudinal strain over the amidships cross-section of a waterborne 320-ft. hull of relatively simple construction were followed for a 48-hr. period. Weather conditions were ideal for this test; on both days bright sunlight shone from a nearly cloudless sky, and nights were relatively cool. Temperatures of the structure varied through a 70 F. range. The strain readings obtained indicated a total range of stress variation of 8000 psi.

One of the most pronounced effects was that observed in the east gunwale which, when warmed 43 F. by the morning sun, developed a 6000 psi. change of stress in the compressive direction over a 2-hr. period. This stress increment is about 70 per cent of that which would theoretically result from a 43 F. temperature change under complete restraint. Simultaneously a compressive stress component of 1500 psi. was observed in the opposite bilge, while small tensile stresses were indicated in the other two diagonally opposite corners of the hull.

As the day progressed, the pattern of stress variation followed the directions and comparative magnitudes which would be expected from the observed temperatures. Correlation of absolute stress magnitudes with temperature would be, as Mr. Vasta indicated, a complex problem. Restraint evidently depends upon a number of factors, including the proportion of material in a structure subject to a given thermal expansion and its location with respect to the neutral axis of bending.

Stress and temperature variations for the two days were generally similar. During the night, strain gage readings agreed with those obtained 24 hr. previously within about ±10 microinches per inch. Temperature and strain indications were relatively steady by 4 hr. after sunset, but continued to shift slowly until sunrise.

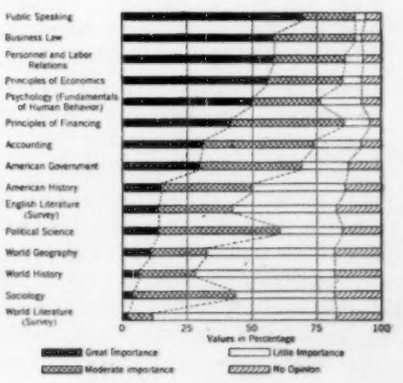
[2] Engineer, Development and Research Branch, Central Technical Dept., Bethlehem Steel Co., Shipbuilding Division, Quincy, Mass.

Importance of Nontechnical Subjects

PROFESSOR Roy M. Green, Head of Civil Engineering Department, University of Nebraska, in a most interesting article published in February *Civil Engineering* discusses the need for a broad training as indicated by a questionnaire he sent to over 100 engineers. Reproduced here is the chart showing the relative importance of nontechnical subjects as measured by the results of the questionnaire. Many of those who replied discussed in detail their conclusions on the matter.

Of interest to BULLETIN readers is the fact that second on a list of items in a chart showing the relative importance of civil engineering subjects was Engineering Relations, Contracts and Specifications.

The results shown in the accompanying chart are in line with emphasis given by several editors of business journals in a series of discussions before the Eastern Section of the Society for the Promotion of Engineering Education. Obviously, editors might be expected to stress the importance of the written and the spoken word, but in several cases the statements were documented by data obtained from a considerable cross-section of technical men.



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The Role of Specifications in the Winning of a War—

An Interesting Message from President Townsend Based on his European Trip

IT WAS my privilege during June and July to visit Germany as an investigator for the Technical Industrial Intelligence Committee and the Combined Intelligence Objective Committee of the Chiefs of Staff. Whereas my particular assignment dealt with an investigation of communications plants devoted to the manufacture of equipment, and engineers and scientists concerned with communications, ample opportunity was presented for broad general observations. During the course of the work, it was necessary to travel about 5000 miles in Germany by automobile to cover the western portion of Germany, occupied by the American-British-French armies, in a zone stretching from the North Sea to Lake Constance in the south. Every facility was provided to make it possible to interview German scientists and engineers, covering a wide variety of technical interest and to observe at first hand the effect of the war on German industrial and economic life. As a result of frequent meetings with other investigators, covering other fields, a broad first-hand picture of the general situation in Germany was revealed. Of particular significance to A.S.T.M. membership perhaps are the methods or lack of engineering tests used to control raw materials and the part played by engineering specifications in the technical life of Germany.

There have been many pronouncements as to what caused the collapse of the German productive system, depending upon the position and field of view of the observer. A broad view of the situation will show there is a fundamental difference between the American and German methods of producing adequate weapons. It cannot be said that American weapons were superior to the German weapons in every field. This situation was mixed. However, it can be said that we had an overwhelming supply of all of the needed weapons, whereas Germany had to endure the many bombings aimed at her industrial plants and consequently had to rebuild destroyed plants and disburse manufacture. On the other hand, it was necessary for us to transport a great majority of our equipment from the United States over the Atlantic. This tended to increase the need for quantity production of ships and associated equipment and to provide transportation and storage facilities abroad. The fact that we were able to accomplish this so well depends upon certain fundamental approaches that are developments of American technological culture.

The German designer appears to think in terms of technological importance and is inclined to overcomplicate rather than simplify his designs. The American designer, on the other hand, tends to simplify the design and to view the design of his equipment in terms of available high-speed manufacturing methods. The trend in American manufacture is toward the use of greater power, more automatic machinery, and a greater degree of mechanization of manufacture. This requires the production of an abundance of material of uniform dimensions and quality to be fed to this automatic machinery. It is only with such material that the automatic machines can work unattended and produce myriads of parts of identical form and quality. To control the uniformity of the raw material it is necessary to develop methods of test. It is also necessary to develop and adopt methods of inspection and quality control. The core of the matter is the development of tests that can be used to measure and indicate variability in quality. This has been the primary concern of A.S.T.M. and our principal contribution to the war effort has been the preparation of such tests and the embodiment of them with proper tolerances into specifications. The use of quantity production and quality control of materials has resulted in the production of an overwhelming amount of weapons that could be used in the war.

The German system, on the other hand, was based on individual workmanship and on the skill of the workman. Considerable judgment with regard to tolerances and the fit of parts was placed in his hands. It was my observation that German manufacturing plants contained thousands of hand files and hand tools and it was only in rare instances that modern high-speed production machinery was noted. In most instances where high-speed production machinery was observed, the rate of production was always less than the American counterpart. This explains in part the tremendous need for more labor that existed in Germany and why they used so much slave labor. The slave labor, in turn could not be expected to use complicated, modern machinery. This required the building of simple assemby fixtures and production

J. R. Townsend and his Car Somewhere in Germany.

equipment and added to the vicious circle. Few, if any, raw materials specifications were observed in Germany and most of the plants were not well equipped with modern testing equipment or control laboratories. It seemed to be the custom to submit materials to commercial testing laboratories and these in turn were not as well equipped as plant or commercial laboratories in the United States. It must be concluded, therefore, that the over-all quality of German equipment was much inferior to American equipment and was not available in the overwhelming quantity needed to win a war.

A further illustration of the inability of the Germans to comprehend the use of high-speed production was their early freezing of designs intended for quantity production. The American system permitted taking advantage of current improvements in design and of scientific advances. This was often accomplished by the use of replacement and modernization kits. If the original design is soundly based on the use of modern production machinery, improvements may be added without disruption of production or interchangeability of parts.

My observations abroad demonstrated in a most graphic manner the importance of the work of A.S.T.M. both in the character and quality of our work and its relationship to national economy. Looking to the future we must make labor more productive and this requires mechanization of manufacture and still further improvements in quality of raw materials and in the power and application of our production machinery. The life blood of this system is standards of quality and accurate methods of test.

J. R. Townsend

PRESIDENT

Society Headquarters Building Developments

Plans Progressing; Fund Subscribed—Donors to be Listed

THE MEMBERS will be interested in developments concerning the new Society Headquarters since the announcements in the August BULLETIN.

The Building Committee has been enlarged by the appointment of the President and the two Vice-Presidents of the Society so that its membership now comprises the following: Judson F. Vogdes, Jr., Director, Philadelphia Committee, Pennsylvania Economy League, *Chairman;* E. J. Albert, General Manager, Thwing-Albert Instrument Co.; T. A. Boyd, Head, Fuel Dept., Research Laboratories Div., General Motors Corp.; Arthur W. Carpenter, Manager of Testing Laboratories, The B. F. Goodrich Co.; G. H. Clamer, President and General Manager, The Ajax Metal Co.; P. H. Dike, Asst. Director of Research, Leeds & Northrup Co.; Alexander Foster, Jr., Vice-President, Warner Co.; John R. Townsend, Materials Engineer, Bell Telephone Laboratories, Inc. This committee has been given authority in the establishment of the new Headquarters.

Plans for alterations and additions to the building have been approved and detailed drawings and specifications are being prepared. The Society gained complete physical possession of the building on October 15 when the last tenants moved from the premises. A general contract for the work is expected to be let shortly and actual construction may be under way by the time this is being read.

While it is not possible to give a definite date when the Headquarters building will be in shape so that the Staff can move in, it is hoped to occupy the building shortly after the first of the year.

Building Fund:

We are happy to announce that the goal established for the A.S.T.M. Building Fund has not only been reached but has been exceeded and that the total subscriptions on October 5 were $137,906. The Executive Committee will continue to receive contributions to the Building Fund from members who have been planning to participate in this project but have not yet done so.

The Executive Committee has also decided that such monies as remain after all alterations, additions, and furnishings of the new Headquarters have been paid for will be placed in a permanent Building Fund (established as a fund separate and distinct from all other funds of the Society) the principal and income of the fund to be used solely for capital expenditures on Society Headquarters. Expenses of operation (equivalent to the present rental expenses) will be met from the general operating income of the Society. Consideration is being given by the Finance Committee to the problems of depreciation and amortization.

The Executive Committee plans to publish in the December ASTM BULLETIN the list of names of all contributors to the Building Fund, both company and individual. Some suitable recognition of these contributors is planned in connection with the formal occupation of the Society's new home.

Looking down the Benjamin Franklin Parkway toward Philadelphia's City Hall from the steps of the Art Museum. The Franklin Institute is the white building at right center. New A.S.T.M. Headquarters Building is just to the left of this, barely visible.

Administrative Staff Reorganized

Executive Committee Implements By-law Changes

AT ITS meeting on October 16 the Executive Committee took the first steps authorized by the new By-laws in a reorganization of the Headquarters Staff. The office of Secretary-Treasurer was changed to Executive Secretary; and the following positions were established: Assistant Executive Secretary; Technical Secretary as head of a "Technical Activities Department"; Editor as head of an "Editorial Department"; Assistant Secretary as head of a "Field and Secretarial Department"; Treasurer as head of a "Finance Department"; and Office Manager as head of an "Office Management Department." The approximate division of staff activities and responsibilities under these five departments was set forth in the 1945 Annual Report of the Executive Committee and is repeated here for convenience.

Technical Activities Department—responsible for all administrative contacts with the technical committees of the Society, including research committees, and with joint and sectional committees; for technical cooperation with Governmental agencies; and for technical and committee sessions of national and district meetings. This will include administrative responsibility for research, development of tests and specifications, reports, special articles, etc.; expansion of technical activities; committee membership and records; committee meetings, minutes; technical inquiries and correspondence.

Editorial Department—responsible for the editing and printing of all publications; also responsible for technical library.

Field and Secretarial Department—responsible for the following activities: District activities, including meetings and programs, personnel records, reports, etc.; exhibits and certain phases of national meetings; developmental activities including membership, publication sales and general publicity; advertising; and miscellaneous secretarial duties.

Finance Department—responsible for membership records, including geographical and industrial classifications and correspondence; receipt and disbursement of all monies of the Society; accounting, cost and other financial records, including those of the Employees Retirement Plan; and custody of securities.

Office Management Department—responsible for the following activities: Distribution and sales of publications, including shipping and stock records; mail, addressograph and duplicating work; general files; office supplies; and the general problems of office management, including headquarters maintenance, telephone switchboard, etc.

In addition to the above positions, the Executive Committee has re-affirmed the positions of Standards Editor and Assistant Editor and has also provided for the appointment of two Assistant Technical Secretaries in the Technical Activities Department. For the present no action has been taken with respect to the appointment of an Office Manager; the duties assigned to an Office Management Department will continue to be carried on as heretofore pending the formal establishment of the new department. All of the other offices have been filled by the following appointments:

Executive Secretary—C. L. WARWICK
Assistant Executive Secretary, Technical Secretary, Editor—R. E. HESS
Treasurer—J. K. RITTENHOUSE
Assistant Secretary—R. J. PAINTER
Assistant Technical Secretary, Standards Editor—P. J. SMITH
Assistant Technical Secretary—C. S. COLE
Assistant Editor—G. A. WILSON

Messrs. J. H. Wolf and M. D. Huber, staff members, serve in the Editorial Department working principally in the editing and publishing of standards.

Expansion of the technical staff, especially with respect to the technical activities and editorial departments, has been authorized by the Executive Committee. The new setup will serve effectively as a framework upon which such expansion can be developed.

It will be understood from the nature of the amended By-laws that the establishment of the new Board of Directors must be postponed until the charter has been revised so that the new Board of Directors will come into existence at the close of the 1946 Annual Meeting. Charts showing the organization of the Society and the technical and administrative activities are in course of preparation and will be published in a later issue of the BULLETIN.

Members' Aid Asked on Membership

Geographic List of Service

IN THE near future each member of the Society will receive from the Executive Committee's Subgroup on Membership a return form by which he may designate the names of companies and individuals who might benefit from affiliation with the Society or who might be in a position to aid in connection with the technical work. The Committee on Membership is headed by W. C. Hanna, Chief Chemist, California Portland Cement Co. Every member is urged to cooperate in this activity.

While it will not be necessary for members to determine whether companies and individuals which occur to them are members or not, since this will be done before any communication is addressed to the prospects, a feature that has been added to the 1945 Year Book, to be distributed soon to all those members who have requested it, will be of interest.

In addition to the usual list in alphabetical sequence, for the first time since 1931 the Year Book includes a list based on geographical location. This geographical distribution list of the United States and foreign countries gives names of the members, whether company or individual, and also the official Society representatives of all company members. Those who wish to use the geographic and check on company connections can do so quite readily by referring back to the alphabetic list.

At the October Executive Committee meeting there was reviewed the Executive Secretary's report on membership which indicated that as of September 29 the total number of members exceeded 5700. This figure does not include the some 200 student members. Through September, 530 new members had become affiliated with the Society, which was slightly better than for the corresponding nine-month period in 1944.

Dates for Annual and Spring Meetings Confirmed

National Meetings to Be Held in Buffalo and Pittsburgh

WITH restrictions on meetings lifted and the regulations on travel also eased, the Executive Committee has confirmed the dates for the Society's 1946 Annual Meeting to be held in Buffalo June 24 to 28, inclusive, and also to have in conjunction therewith the Society's Seventh Exhibit of Testing Apparatus and Related Equipment. A.S.T.M. Committee Week will be held in Pittsburgh during the week beginning February 26 and a Spring Meeting with one or more technical sessions during the week, probably on Wednesday, February 28. These meetings will be at the Hotel William Penn.

Arrangements have been made with hotels in both Buffalo and Pittsburgh to guarantee a number of sleeping rooms which should meet the members' requirements, but in both localities a housing bureau will be set up through the Convention Bureau to function much the same as for the Society's 1944 Annual Meeting in New York where several hotels cooperated. Members will be fully apprised of the hotel situation and will receive forms or advice on making reservations. In Buffalo, the main sessions, Exhibit and Registration Desk will be at The Statler.

Fourth Installment of Preprints

THE fourth installment of preprints of reports and papers is now on press and will be distributed to all members who have requested them. The installment will include:

Reports:

Report of Committee A-5 on Corrosion of Iron and Steel

Report of Committee D-13 on Textile Materials

Papers:

A Study of Size Effect and Notch Sensitivity in Fatigue Tests of Steel—H. F. Moore

The Effect of Combined Stresses on the Mechanical Properties of Steels Between Room Temperatures and −188 C.—D. J. McAdam, Jr., G. W. Geil, and R. W. Mebs

A Sulfur Print Method for the Study of Crack Growth in the Corrosion Fatigue of Metals—R. C. Brumfield

A Comparison of Absorption and Soundness Tests on Maine Sands—Andrew Adams and Horace A. Pratt

Fatigue Tests of a Laminated Mitscherlich Paper Plastic—W. N. Findley

The reports and papers for publication in 1945, listed on pp. 83–89 of the May ASTM BULLETIN, were distributed throughout the year as they became available in accordance with the new policy of distribution of preprints. Four technical papers were distributed through a preprint request blank included on p. 40 of the March ASTM BULLETIN; the remainder that were available have been distributed through the usual preprint request blank mailed to all members of the Society in May, the first three installments being put in the mail prior to the Annual Meeting in June and the above-mentioned fourth installment going into the mails this month. In addition to these advance distributions, seven papers were included in the May, August, and October ASTM BULLETIN.

Offers of Papers for 1946

THE Administrative Committee on Papers and Publications will meet in February (about Feb. 21) to consider the papers to be published by the Society in 1946 and to develop the program of the 1946 Annual Meeting to be held in Buffalo, N. Y., June 25 to 29. All those who have in mind offering papers for presentation at the Annual Meeting and publication by the Society should send these offers to Society Headquarters well in advance of the February meeting of the committee.

All offers should be accompanied by a summary which should make clear the intended scope of the paper and indicate features that, in the opinion of the author, will justify its inclusion in the Annual Meeting program and publication by the Society. Suitable blanks to be used in transmitting the desired information will be sent promptly on request.

Technical papers are preprinted and distributed to the members throughout the year as they become available. In other words, manuscripts that are available early need not be held for printing just prior to the Annual Meeting. It is therefore urged that all manuscripts be submitted as early as possible for prompt distribution to the members.

There is one point which might well be kept in mind—the committee does not judge the contribution on the basis of length or comprehensiveness of the paper. A review of A.S.T.M. *Proceedings* will indicate that a very large number of pertinent and important contributions are short, or relatively so, although, of course, there are numerous items that are extensive.

All Items on Society Letter Ballot Approved

ALL items referred to the membership in the 1945 letter ballot, the results of which were canvassed on September 15, have been approved. This includes 44 tentatives recommended for adoption as standard and revisions in 38 existing standards. Details of these changes were given in the reports of the technical committees distributed to the membership on request and in the *Summary of Proceedings* which went to all members.

In addition to the actions on standards, the proposed amended By-laws which had been distributed to the members as Circular 264 on May 24 were approved. With one exception, the By-laws are now effective. The revisions provide for a more suitable classification of members, broader qualifications for honorary membership, elimination of provision for membership in perpetuity, change in title of "Secretary-Treasurer" to "Executive Secretary," and substitution of the collective noun "Tentatives" for "Tentative Standards." Another item, the substitution of a Board of Directors for an Executive Committee as the governing body of the Society, has been approved but will not become effective until the 1946 Annual Meeting since these changes affect the charter, amendment of which is now being sought in line with the action taken at the Annual Meeting.

Important Publications off Press Soon

SEVERAL important technical publications are practically completed and by the time this BULLETIN is mailed they may already be in the course of distribution. In October two books of widespread interest to different segments of the membership became available, the compilation of Standards on Petroleum Products and Lubricants, which has been sponsored annually for many years by Committee D-2, and the extensive technical Symposium on Stress-Corrosion Cracking of Metals which as announced previously is sponsored jointly by the Society and the A.I.M.E.

The 1945 Year Book is being released for press, with distribution expected by the middle of November to all those who have requested copies. The Symposium on Magnetic Particle Testing is on press and the extensive report on Impact Tests on Metals at Low Temperatures, which was prepared by Dr. H. W. Gillett of Battelle for the War Metallurgy Committee, is also about completed. Another compilation of standards is the one covering Electrical Insulating Materials developed by Committee D-9. This should be ready soon.

Concerning the Year Book, reference is made in an article on membership elsewhere in this BULLETIN to the inclusion for the first time in many years of a list of members according to geographical distribution and it is hoped this feature plus a number of other changes in the book will make it of still more service to the members. An opportunity was given earlier for members to request a copy and those who did not return their card but who want a Year Book should write promptly because it is sent only on request.

Members Order Blank:

Following the customary procedure, there will be distributed to each member of the Society about the middle of November a special Members Order Blank with descriptive material about the Society's publications, thus enabling members to order any of the books at the special prices which are considerably lower than the list prices. With the exception of the jointly published Stress-Corrosion Cracking Symposium, members can obtain all of the books in quantity at a still lower cost. With this mailing will be special prospectuses, one covering the A.S.T.M.-A.I.M.E. Symposium, from which it will be noted that *all orders for this are to be sent to the A.I.M.E. office in New York.*

Advance Orders:

For those members who do not wish to defer ordering publications until the Members Order Blank is available, the following information may be of interest.

Symposium on Stress-Corrosion Cracking:

Thirty papers by foremost metallurgists of this country and Great Britain. Five hundred pages, coated paper, cloth binding. First copy to either A.S.T.M. or A.I M.E. members $5. Nonmembers U.S.A. $7.50; nonmembers foreign $8. All orders accompanied by check should be sent to A.I.M.E., 20 W. 39th St., New York 18, N. Y.

Compilation of Standards on Petroleum Products:

Includes the 100 test methods, specifications and definitions covering petroleum, materials for roads and pavements, etc., most of which were issued by Committee D-2. 560 pages, heavy paper cover. Members prices—1 to 9 copies, $1.80; 10 to 49, $1.60; 50 and over, $1.50. The respective list prices are $2.75, $2.10, and $1.90.

Compilation of Standards on Electrical Insulating Materials:

This October, 1945, edition supersedes the previous one issued two years ago. All of the some 80 specifications and test methods issued by A.S.T.M. are given and there is other significant appended material including reports on significance of tests. There is a detailed index. Some 570 pages, heavy paper cover. Members prices—1 to 9 copies, $2.20; 10 to 49, $1.90; 50 and over, $1.75. The respective list prices are $3.25, $2.50, and $2.25.

Further announcements will be made concerning dates and prices for our other publications.

Alphabetic Indices of X-Ray Diffraction Patterns

Two rather extensive publications have recently come off press comprising separate indices to the original and the supplementary sets of X-Ray Diffraction Data Cards. While these indices are of practical use only to those who have available the sets of cards as described in some detail in the August BULLETIN, the publication of the indices is newsworthy. Published by the offset process, the original sheets for the two books, 110 and 176 pages, respectively, were prepared by Prof. Wheeler P. Davey and his associates. Professor Davey is Chairman of the Joint Committee on Chemical Analysis by X-Ray Diffraction Methods of the American Society for X-Ray and Electron Diffraction, the American Society for Testing Materials, and the (British) Institute of Physics which has the sponsorship of this very valuable and interesting publication and which, as the August BULLETIN brought out, has resulted in the issuance of eight box files of cards, aggregating a total of almost 9000 cards. The indices are furnished without charge to purchasers of the original and supplementary sets of cards which sell, respectively, for $50 and $75 per set.

"Atomic" Book of Standards

WHILE quite a large number of copies of the 1944 Book of Standards had been going to certain "war" plants in southern and southwestern United States, it was not until the newspaper and other bombasts on the atomic bomb were released that we knew our Books of Standards were going to plants where the atomic bomb or parts of it were in production. We are, of course, not apprised of the uses to which our specifications and tests were put, but from the large number of books ordered there must have been some very practical applications.

One member has facetiously suggested that if the top scientists involved had really given serious thought one of the books might have been dropped on Japan with perhaps not quite as widespread effect as the atomic bombs but certainly considerable disturbance in the area where the extremely hefty tomes landed.

Administrative Committee on Simulated Service Testing

THE second meeting of the Administrative Committee on Simulated Service Testing was held at the Society's Headquarters in Philadelphia on September 27 with Chairman L. L. Wyman presiding. At this meeting two very important steps looking toward the expansion of the Society's activities in the field of testing were taken. The first of these was the result of the committee's study of the need for developing methods of test for building constructions. These are required not only for prefabricated building units but for the more conventional types of erected-on-site construction. The committee felt that in order to assure the desired results of better service in building construction it is necessary to take cognizance of the three primary elements contributing thereto: namely, (1) materials, (2) engineering design, and (3) fabrication details. Methods of test for evaluating all of these, a survey showed, would be most welcome by code officials, architects, and others in the building industry.

These facts had been developed at a meeting held at the National Bureau of Standards in Washington on September 24 of selected representatives of the building industry, under the chairmanship of Mr. D. E. Parsons, a member of the Administrative Committee, to review the possibility of A.S.T.M. action in this field and what direction it should take. As a result of the discussion at this meeting, reported by Mr. Parsons, the Administrative Committee voted to recommend to the Executive Committee of the Society that there be established a Committee on Methods of Testing Building Constructions, with the following scope of activities:

> To formulate methods of test for building constructions, including elements, connections, and assemblies, under actual or simulated service conditions, applicable to the evaluation of such factors as materials, design, construction, and fabrication.

The Administrative Committee is further recommending to the Executive Committee that Mr. L. J. Markwardt of the Forest Products Laboratory in Madison, Wis., be designated as temporary Chairman to organize the committee and Mr. J. H. Courtney of the American Standards Association be designated temporary Secretary. The Administrative Committee also reviewed carefully a list of names which had been suggested for the initial personnel and 30 of these were selected and are being recommended to the Executive Committee and the new committee officers.

The second important step taken at the meeting of the committee was a recommendation to the Executive Committee that the Society's present Research Committee on Fatigue of Metals be reconstituted as a Committee on Fatigue. The scope being recommended for this committee is as follows:

> To formulate methods for the determination of fatigue characteristics of simple and composite materials, components, and processed parts, and to promote research in these fields.

The work of the present Research Committee will be continued as a subcommittee activity.

A.S.T.M. has long taken the lead in the study of fatigue and this recommended expansion of the scope of our work in this field will greatly enhance the Society's opportunity for service. President Townsend has designated R. E. Peterson of the Westinghouse Electric Corp. to serve as temporary Chairman of the reorganized committee and the selection of personnel is now proceeding.

Another subject discussed at some length at the meeting of the Administrative Committee was the possibility of holding symposiums on the subjects of Testing Parts and Assemblies and on Fatigue Testing at the next annual meeting of the Society in Buffalo, June, 1946. The Administrative Committee and members of the Headquarters Staff are exploring this field and it is hoped that definite plans can be made at the next meeting of the Committee, which will be held in November.

Committee B-5 on Copper and Copper Alloys

DURING the War Period the officers and members of Committee B-5 were among the busiest in the Society. Thanks to foresighted preparation before Pearl Harbor most of the wrought metal specifications under the jurisdiction of the committee had been reviewed and changes had been made which made them satisfactory for mass production of war matériel. However, there had been no time to make a review of the specifications for uniformity and other minor details which needed adjustment.

This work the committee is now proceeding to do, and the first steps were taken at a two-day meeting in New York on September 11 and 12 of the main committee and most of its subcommittees held at the Engineering Societies Building. Some of the actions taken are of interest to all A.S.T.M. committee members because similar steps can be taken in many other specifications which will improve their utility to both the producer and the consumer.

Probably the most important and constructive step was to approve and begin to apply to the specifications a recommendation from the newly reorganized Subcommittee on Methods of Test. This recommendation to the other subcommittees of B-5 was that the prescribed chemical composition and physical properties in all B-5 specifications should indicate clearly the number of significant figures to which the procedure outlined in A.S.T.M. Designation E 29 – 40 T, Section 4, should apply. (The latter prescribes the method for dropping figures beyond those considered significant.)

Another important action was to standardize the rejection paragraph in all the wrought metal specifications so that it will read:

> Material that fails to conform to these specifications will be rejected, and the manufacturer shall be notified within 30 days after receipt of the material.

As defects often show up in castings on machining which are not evident in the inspection of the rough castings, the standard rejection clause for brass and bronze castings under the committee's jurisdiction will contain two additional clauses as follows:

Material that, subsequent to test and inspection at the factory, or elsewhere, and its acceptance, shows injurious defects will be rejected and the manufacturer shall be notified.

The full weight of the original material rejected shall be returned to the manufacturer. The manufacturer shall not be responsible for the costs of machining defective castings.

Considerable attention was also given to a review of the present methods of tension testing as applied to rod and bar stock, particularly with a view toward standardizing on the ratio between gage length and diameter (or distance between flats) as well as the proposal to use full size test specimens, wherever possible.

All of the subcommittees dealing with wrought metal and the subcommittee dealing with castings and ingot met and in addition to taking action on the items noted above reviewed numerous specifications under their jurisdiction.

Committee B-9 on Metal Powders and Metal Powder Products

TRAVEL restrictions during the Spring and Summer prevented holding a meeting of Committee B-9. However, its Advisory Committee met in Cleveland on July 12, with Chairman W. A. Reich presiding, to review the progress to date and to outline future activities of the committee.

It had been possible to carry on some of the work of the committee by correspondence and as a consequence the new Tentative Specification for Metal Powder Sintered Bearings (Oil Impregnated)—B 202, has been prepared by the committee and has been approved by the Administrative Committee on Standards.

Three other tentative test methods covering (a) screen analysis, (b) flow, and (c) apparent density of metal powders have been prepared in the subcommittee and are currently being voted on in the main committee; these should soon be ready for submission to the Society.

The Subcommittee on Nomenclature and Technical Data is proceeding with the preparation of a glossary of terms and definitions used in the metal powder industry and this too should be ready for publication sometime this winter. Other problems, with which the committee is currently working, deal with the study of sub-sieve particle size analysis methods, and the study of the requirements for cemented carbides, electrical parts, and friction materials.

Meeting of Committee D-14 on Adhesives

MEETINGS of Committee D-14 on Adhesives and its subcommittees were held in Atlantic City, N. J., at The Claridge on Tuesday and Thursday, October 9 and 11. On Wednesday, October 10, an extensive Symposium on Adhesives sponsored by Committee D-14 was held at which papers were presented in morning and afternoon sessions.

Subcommittee meetings were held all day Tuesday. The meeting of Subcommittee I on Strength Tests lasted practically the entire day and was an excellent meeting, attended by approximately 40 people. No test methods were accepted, but several were suggested subject to editorial correction before submission to letter ballot, and several other methods about which there was some discussion, were recommended for round-robin testing. The subject which seemed to arouse most discussion was shear testing, and it was agreed to do further work.

Dr. Gordon Kline reported for his Subcommittee VI on Nomenclature and Definitions that a letter ballot covering a number of terms used in adhesives testing would soon be canvassed.

On Thursday more subcommittee meetings were held and also a meeting of the main committee. The subcommittee meetings dealt with testing for permanency. Several methods were recommended for editorial correction and one or two are to be evaluated by round-robin testing. Subcommittee V on Specifications decided that since several test methods were nearing completion it would commence work immediately. Most of those present expressed a preference for specifications on a performance basis. The committee also discussed the idea of having another symposium sometime in the future.

District Meetings in Chicago, Detroit, Pittsburgh, Cleveland and New York

President Townsend, C. F. Kettering, Clyde Williams, T. A. Boyd, A. Allan Bates, J. Bennett Hill on Programs

DISTRICT COMMITTEES in several industrial centers have planned most interesting meetings and as this BULLETIN nears press such meetings are already under way in Chicago on October 24 and in Detroit on the following day. The Pittsburgh District plans what should be an equally interesting session on November 29 and Cleveland expects to follow through with a meeting on December 4. The New York meeting on the subject of Fuels and Lubricants is planned for December 11. Notes on these meetings appear below and others are in prospect in other districts including Philadelphia and Southern California. In all cases direct-mail notices are sent to all A.S.T.M. members and committee members in the district and the Society

officers, members of all district committees, and technical men and engineers affiliated with some of the local engineering societies and sections are also notified.

Detroit:

Since the meeting in Detroit on October 25, as developed by this very active District Committee, has influenced plans in other districts, it is briefly described first. President Townsend was approached by the district to discuss the subject "Research Revolutionizes Materials" and joining him is Dr. C. F. Kettering, Vice-President of General Motors Corp. and Director of its Research Laboratories. Mr. Townsend has spent about two months during the summer in Europe traveling many thousand miles and in his talk will make some observations on this and also embody some of the conclusions from his extensive experience in the field of materials from his long-time work as Materials Standards Engineer and later Materials Engineer with Bell Telephone Laboratories.

Dr. Kettering, who will follow Mr. Townsend in the program, is expected to give one of his inimitable talks which are so interesting and fascinating to all who hear him. It is hoped to include in the December BULLETIN, at least extended abstracts of these addresses.

In planning the meeting, Mr. Carl Heussner, Chrysler Corp., has been program chairman, W. C. Ducomb is in charge of publicity and promotion, W. P. Putnam, The Detroit Testing Laboratory, is dinner chairman, and other district members have aided including C. H. Fellows, The Detroit Edison Co., F. P. Zimmerli, Barnes-Gibson-Raymond Division of Associated Spring Corp., and T. A. Boyd, General Motors Research Laboratories, A.S.T.M. Vice-President. The District Chairman and Secretary, Messrs. Martin Castricum, U. S. Rubber Co., and V. M. Darsey, Parker Rust-Proof Co., have been active correlating the various plans. An informal dinner to which all engineers in the district have been invited will precede the session and at this dinner Executive Secretary C. L. Warwick will be introduced and will speak.

Chicago:

With a desire to invite President Townsend to speak at a meeting in Chicago, the District Committee there has arranged a session on the day prior to the Detroit meeting. This will be held in the Engineering Building, and joining Mr. Townsend is T. A. Boyd, A.S.T.M. Vice-President and Head, Fuel Dept., General Motors Research Laboratories. The subject is related to the Detroit meeting with the title "From Research—New Facts—New Materials—New Products." Meeting plans here have been effected through the active work of George E. Stryker, Bell & Howell Co., District Program Chairman, and also assisting J. F. Calef, the District Chairman, have been Messrs. J. J. Kanter and J. de N. Macomb, District Secretary and Vice-Chairman, respectively, and others.

Pittsburgh:

At a well-attended meeting of the Pittsburgh District Committee in late September, the committee took action to invite President Townsend to address its technical session and have also arranged for Dr. A. Allan Bates, Head, Chemical and Metallurgical Dept. of the Westinghouse Research Laboratories, to talk. While Mr. Townsend will cover the subject of "Research Revolutionizes Materials," Dr. Bates will discuss "Tracking Down Research in Wartime Germany." Dr. Bates has recently returned from a rather extensive period in Europe, some five months during the war and also several weeks following. This meeting will be held in the Mellon Institute Auditorium beginning at 8 p.m. sharp, on November 29, and all members and their friends are cordially invited. Invitations are also going to many other engineers and technical men in the Pittsburgh district who are affiliated with chapters of other groups. This is an outstanding meeting which should be of real interest and a large turnout is expected.

Cleveland:

Cleveland District has scheduled its meeting for December 4 at which President Townsend will be joined by Dr. Clyde Williams, Director of Battelle Memorial Institute, whose activities in war research with Battelle and particularly as Chairman of the War Metallurgical Committee are well known to all Society members and among technical men in general. This meeting is to be in the Auditorium of the Cleveland Engineering Society Building, beginning at 8 p.m.

At all of these district meetings, Executive Secretary C. L. Warwick will speak briefly on some of the very interesting developments in A.S.T.M.

New York:

The New York District has been quite anxious to have a discussion on some of the technical and economic aspects of postwar gasolines and related petroleum products and is fortunate in having obtained Dr. J. Bennett Hill, Manager, Development Div., Sun Oil Co., to speak. His talk will be featured at a meeting in Room 501 of the Engineering Societies Building on December 11 and all members in the Metropolitan area and others concerned are urged to note this date on their calendars. Dr. Hill has had long experience in the petroleum field and an authoritative address on this important subject should be of vital interest.

Numerous Technical Councils Active

MANY members of the Society participate in the activities of the various affiliated technical societies councils or combined engineering societies groups functioning in an increasing number of cities. It is surprising to learn of the number of communities where technical councils have been established. Most know of the work in Cleveland, Chicago, Detroit, Boston, etc., but a review of the article on technical councils, in the October issue of *Sci-En-Tech News*, which is the monthly journal of the Chicago council, shows that there are councils in Denver, Baltimore, Atlanta, Louisville, and several other locations.

While each of the councils has certain objectives, perhaps peculiar to their areas, nevertheless one of the fundamental concepts is the coordination of the meetings and certain activities of the local sections and chapters of the societies participating in the council.

Book on Scientific Societies in the United States

THIS detailed account of the evolution of American scientific organizations, including the main national scientific societies, and the state, local, specialized, and technological societies, is interesting reading for it is concerned with the history of many groups that have played such an important part in the scientific life of America. Dr. Ralph S. Bates, of Massachusetts Institute of Technology, the author, has compiled a great wealth of information and data and arranged it in a logical and quite interesting manner, using five main chapters to convey the data as follows: Scientific Societies in Eighteenth Century America; National Growth, 1800–1865; The Triumph of Specialization, 1866–1918; American Scientific Societies and World Science, 1919–1944; The Increase and Diffusion of Knowledge.

The author points out that the scientific societies are among the outstanding agencies for increasing and diffusing the world's store of knowledge. They originated during the Renaissance in Italy and spread across Europe and the Americas and now encircle the globe. They have multiplied most rapidly in the United States. Apparently the first such organization was the Academia Secretorum Naturae, 1560 (Italian), and the first English one, the Royal Society which dates from 1662. In America, the Boston Philosophical Society (1683) probably outdates any others but the American Philosophical Society with headquarters in Philadelphia is the oldest continuing group in America dating from 1743 or 1744. Its present headquarters are in Independence Square.

Concerning the national growth from 1800 to 1865, particularly after 1830, there came a demand for general scientific societies, but also for national specialized groups and many were established. This period was followed by what the author terms the "triumph of specialization" which continued through 1918. It is an amazing era as demonstrated by the establishment and growth of so many valuable and numerous unique organizations in all fields of scientific endeavor.

The author shows that in the period between the Civil War and World War I there was a tendency toward specialization, a slow but sure drift in the direction of national centralization within the specialties, and an increasing tendency to form strictly technological societies. The period from World War I to the present is exemplified by the much larger role American scientists have played in international organization and subsequently the attempts through the National Research Council and other agencies to coordinate scientific endeavor.

An important factor in diffusing knowledge has been the large number of scientific periodicals. *The American Journal of Science and Arts*, established at New Haven in 1818 under the editorship of Benjamin Silliman, was a leading one for many decades.

Concerning the increase and diffusion of knowledge, it is of interest to note that George Washington in his Farewell Address stated, "Promote, then, as an object of primary importance, institutions for the general diffusion of knowledge."

Dr. Bates states that symposia sponsored by the technical groups furnish indispensable forums for the presentation and discussion of scientific papers, offer the most convenient time for threshing out disagreements and difficulties, and give some guarantee against smug complacency or a tendency to be too dogmatic or assertive.

This 260-page book, page size 5½ by 8½ in., with a very detailed index and an extensive bibliography, was sponsored by the Technology Press of M.I.T. and issued by John Wiley & Sons, Inc., in New York from whom copies can be obtained at $3.50.

Post-War Housing

THE interest of many of our members, both from an industrial and personal standpoint, in housing prompts publication of excerpts from an article in the September *Journal of the American Institute of Architects*. Seward H. Mott, Director, Urban Land Institute, in his article "Trends in Post-War Housing" which was part of a symposium issued by the National Committee on Housing, gives careful analyses of data from a series of Opinion Surveys held with selected groups of builders, real estate operators, and mortgage bankers. These surveys were supplemented with conferences and discussion with many other groups comprising hundreds of home builders.

"First, where will the post-war homes be built? With the exception of a few large cities, where there is still a surplus of well-located, improved lots, 75 per cent of the post-war housing is expected to be built on new undeveloped acreage. Improved lots and raw acreage suitable for residential construction are still available at reasonable prices in all cities visited. The maximum desirable distance from various objectives is as follows: Forty minutes to employment, three miles from a major shopping center, two and one-half miles from high schools, half mile from grade school and small store group.

"There is a very strong trend in all parts of the country toward the development of complete residential neighborhoods instead of the construction of small isolated groups of homes.

"The price range of the homes was a matter of very serious discussion. These estimates do not pretend accurately to represent the housing *need*, but they are the price range of homes which the builders are planning to construct in the first two post-war years. Many factors influenced the builders' decisions. A minimum lot size for low-cost homes was 50 by 100 feet, with the tendency toward wider lots.

"The estimated price range and percentage of homes which are expected to be built in the first two post-war years are as follows:

Low cost—$3000 to $6000..23 per cent
Medium cost—$5000 to $10,000.....67 per cent
High cost—$8500 and up...10 per cent

The price range for the different groups varied geographically.

"Average estimates are that 90 per cent will be for sale and 10 per cent for rent.

"In reference to architectural trends, there was uniform agreement that there would be no radical changes in exterior design in any price range. It was felt that it would be some years before the new materials and processes that have been developed would get into production and be available for use in homes. It was the opinion that the post-war home will have more carefully planned interiors, more efficient kitchens, and greater use of mechanical equipment. But even in the

highest cost range, the exterior design will remain conservative. In the South and West, the one-story ranch type is becoming very popular; and in the North, the so-called Colonial will continue to be in demand. There will be some modern touches, such as corner windows and view windows, but flat roofs and modernistic styles are definitely out, in the opinion of the builders, bankers, and real estate brokers that were consulted, and they feel that they reflect the public sentiment.

"The feeling was generally expressed that the public will rent modernistic apartments, but that they become conservative when they buy or build a house.

"Garages will be built for all price ranges, and in the South and West where basements are usually omitted, garages will be made of sufficient size to provide storage room or even laundries. The trend seems to be toward attached garages, and for making the rear yard an outdoor living-room with terraces and ready access provided. Locating kitchens in the front of the house rather than the rear is becoming popular. Great improvements in mechanical equipment, particularly heating, are expected, and fluorescent lighting will be widely installed.

"These findings represent the opinion of the men who are going to put up the money and build the homes. Whether they reflect public desire is a matter of which only time will tell."

Technical Data on Plastics

THROUGH the work of the Plastics Materials Manufacturers' Association (P.M.M.A.) which has its headquarters in the Tower Bldg., Washington, D. C., there has been issued an extensive compilation of data and information which is intended to give the user authoritative facts on the nature, properties, and the merits and utility of various families of plastics.

It is of interest to note that the methods chosen to measure the properties of the materials are the testing procedures established by A.S.T.M., primarily through the work of its Committee D-20 on Plastics. For the most part the data are presented in very extensive tables, following a uniform system. For each of the families of plastics the companies furnishing the data are indicated with information on the various trademarks. While the publication comprises some 163 pages, many of these pages are in the form of folded insert sheets so that actually the publication is much more extensive than the number of pages would indicate. Copies can be obtained from the P.M.M.A., Tower Bldg., 14th and K Sts., N. W., Washington 5, D. C., at $1.50 per copy.

New S.A.E. Technical Board

IN A recent *S.A.E. Journal*, James M. Crawford, President of the Society of Automotive Engineers announces the membership of the newly established S.A.E. Technical Board which is to exercise general direction and supervision over all the technical committee activities of this society. Mr. Crawford points out that the Board is to function both as a main spring and a balance wheel, but that the operations will involve a gradual rather than a sudden transition in effecting coordination of the society's various technical committee operations.

A number of A.S.T.M. members and committee representatives are included in the S.A.E. Board, the personnel of which follows:

SAE TECHNICAL BOARD

L. R. Buckendale, Chairman, Vice-President in Charge of Engineering, The Timken-Detroit Axle Co.
B. B. Bachman, Vice-President in Charge of Engineering, The Autocar Co.
D. P. Barnard, Associate Director of Research, Standard Oil Co. of Indiana
Rex B. Beisel, General Manager, Chance Vought Aircraft, Division of United Aircraft Corp.
Roy E. Cole, Vice-President in Charge of Engineering, The Studebaker Corp.
A. T. Colwell, Vice-President, Thompson Products Co.
R. M. Hazen, Chief Engineer, Allison Division, General Motors Corp.
J. H. Hunt, Director, New Devices Section, General Motors Corp.
R. D. Kelly, Superintendent of Development, United Air Lines
G. W. Laurie, Manager, Automotive Transporation, The Atlantic Refining Co.
William Littlewood, Vice-President, Engineering, American Airlines, Inc.
Erle Martin, Engineering Manager, Hamilton Standard Propellers, Division of United Aircraft Corp.
R. H. McCarroll, Executive Engineer, Ford Motor Co.
Arthur Nutt, Director of Aircraft Engineering, Packard Motor Car Co.
C. R. Paton, Director of Automotive Engineering, Packard Motor Car Co.
L. S. Pfost, Chief Engineer, Tractor Division, The Massey-Harris Co., Inc.
Delmar G. Roos, Vice-President in Charge of Engineering, Willys-Overland Motors Inc.
C. G. A. Rosen, Director of Research, Caterpillar Tractor Co.
A. W. Scarratt, Vice-President, International Harvester Co.
Mac Short, Vice-President, Lockheed Aircraft Corp.
T. C. Smith, Automotive Engineer, American Telephone & Telegraph Co.
Ralph R. Teetor, Vice-President in Charge of Engineering, The Perfect Circle Co.
R. W. Young, Chief Engineer, Wright Aeronautical Corp.
J. C. Zeder, Chairman of the Engineering Board, Chrysler Corp.

A.S.M.E. Annual Meeting

THE general theme of the American Society of Mechanical Engineers' Annual Meeting, to be held November 26 to 30 at the Hotel Pennsylvania, New York, N. Y., is air power. This is a tribute to the A.S.M.E. Aviation Division which is observing its 25th anniversary and also recognizes the important place of air power. Details of the large number of technical meetings and sessions can be obtained from A.S.M.E. Headquarters, 29 West 39th St., New York 18, N. Y.

Paper on Processing Materials from Petroleum

THE TECHNICAL paper on Processing Materials from Petroleum presented by Dr. J. C. Dean of Socony-Vacuum Oil Co. at meetings of A.S.T.M. districts in New York and Chicago, has been published by *Chemical and Engineering News* and copies in separate pamphlet form can to be obtained by contacting the Processing Products Division, Socony-Vacuum Oil Co., Inc., 26 Broadway, New York 4, N. Y. There was considerable interest in this paper and an extended abstract of it was published in the ASTM BULLETIN.

Reprint on Neutralization Number

THE Symposium on Neutralization Number, held under the auspices of Committee D-2 on Petroleum Products and Lubricants and published in the May ASTM BULLETIN, has been reprinted and copies of the ten-page reprint with the five technical papers can be obtained from A.S.T.M. Headquarters at 25 cents each.

Rosie and Gertie were working in a Defense Industry.

Gertie: "Know what I'm doing now, Rosie?"

"No, what?"

"I'm working in inspection using a micrometer."

"What's them?"

"Oh, you use them to measure things with. I'm measuring to one ten-thousandth of an inch."

"Gee, that's close. How many ten-thousandths in an inch?"

"I don't know, but there must be millions!"

The Penn State Engineer

Past-President P. H. Bates Retires

On September 15, P. H. Bates, Chief of the Division of Clay and Silicate Products, National Bureau of Standards, retired from active work at the Bureau. This voluntary move on his part thus severs a period of 35 years of intensive service during which time he has had a leading part in many developments in his field of activity. He has been a member of the Society since 1910 and served as its President in 1944 to 1945. Earlier he was associated in the Altoona Laboratories of the Pennsylvania Railroad Co. with the Society's first President, Charles B. Dudley. Later he was with the U. S. Geological Survey. In the period from 1910 to 1919 he was in charge of the Pittsburgh Branch of the National Bureau of Standards.

One of his notable contributions has been in the field of optical glass; the important work carried out by the Bureau in producing suitable glasses for the armed services was under Mr. Bates' direction. He was vitally concerned with the work on Federal specifications and participated in many technical societies including the American Ceramic Society and the American Concrete Institute of which he was president from 1934 to 1936.

Those who know P. H. Bates keenly appreciate his sound judgment and incisive comment. In the Society he has had much influence in the field of cement and concrete and has served as Chairman of Committee C-1 on Cement from 1926 to 1945. Recognitions of his abilities were many. His selection as the 1940 Edgar Marburg Lecturer and the award of the Concrete Institute's Gold Medal are but some of the tangible evidences of the high esteem in which he was held.

His retirement as Chairman of Committee C-1 is felt keenly by all of the members and with unusual spontaneity a luncheon was arranged in Mr. Bates' honor by the committee members at which many of the members were present. This was held at the Hotel Shoreham on September 5. Many of those present took occasion to express appreciation of Mr. Bates' many fine qualities and of his contributions to the work of the committee. Two engraved silver platters were presented to him as a remembrance.

Mr. Bates is continuing his interest in A.S.T.M. as a member of the Executive Committee, but is relinquishing his chairmanship of Committee C-1. He is also retaining the chairmanship of the Advisory Committee on Long-Time Studies of Cement Performance in Concrete.

While Mr. Bates retains his Washington home, he and Mrs. Bates plan to spent their winters in St. Petersburg, Fla., in their recently acquired home at 245—25th Avenue North.

The Personals Column of this Bulletin mentions the appointment of D. E. Parsons to succeed P. H. Bates as Chief of the Clay and Silicate Products Division at the Bureau.

J. O. Leech Honored by Steel Committee

In recognition of his outstanding service, particularly in connection with the development and promulgation of steel specifications, Committee A-1 on Steel through its Advisory Committee recently presented to J. O. Leech one of its most active and long-time members an engrossed scroll to which all Advisory Members' signatures had been affixed. Mr. Leech, who for over forty years had been with the Carnegie Steel Co. and its successor, devoted a great amount of time and effort in steel specifications work, particularly nomenclature, arrangement, etc., in which he is one of the country's outstanding authorities. The inscription on the scroll reads as follows:

Committee A-1 on Steel
of the
American Society for Testing Materials

By unanimous action of its Advisory Committee extends greetings and best wishes to

J. O. LEECH

A member of Committee A-1 since 1912 and of the Advisory Committee since 1929, he has worked constantly to prepare specifications of national and international importance.

His gift for the precise use of the English language has been of great value in giving clarity and validity to these specifications and Committee A-1 hereby expresses its appreciation of his excellent and enduring work.

The Secretary of the Steel Committee, R. J. Painter, who presented the scroll to Mr. Leech in Cambridge where Mr. and Mrs. Leech have been spending the summer with their son, Captain Robert C. Leech of Watertown Arsenal, reports that "Ollie," as he has been so widely known, is in excellent spirits and is in much better physical condition generally than earlier this year. His doctors have ordered him to spend the winter in Florida and he expects to be at the Osceola Inn, Clearwater. He has appreciated very much the messages and communications from various people with whom he was associated and regrets his inability to acknowledge all of them.

Change in A.F.A. Officers

A number of changes have been made in headquarters officers of the American Foundrymen's Association by action of the A.F.A. directors at its late summer meeting.

William M. Maloney, formerly Business Manager of the Association, was elected Secretary and chief administrative officer. Robert E. Kennedy, who is well known to many A.S.T.M. members, was designated Secretary Emeritus in view of his outstanding services as A.F.A. Technical Secretary and Secretary. N. F. Hindle continues to direct the Technical Development Program and C. E. Hoyt continues as Treasurer.

The National Officers include men who are active in A.S.T.M. work, including the new President, F. J. Walls, International Nickel Co., in Detroit.

There have been very close relations for many years between A.F.A. and A.S.T.M. and the association has been a member of the Society continuously since 1898.

EMPLOYMENT

BEGINNING with this BULLETIN, this new column of employment covering "Technical Help Wanted News" and "Technical Services Available News" will be instituted for the use of members. No charge will be made in the case of A.S.T.M. members or official representatives of company members, but the right to edit copy and reject insertions is reserved. The column is for the use of members and is not available otherwise. In each case insertion notices should be sent to the BULLETIN editor, a box number will be assigned, and mail forwarded on receipt.

TECHNICAL HELP WANTED

A.—A large well-established manufacturer of machines for physical testing of materials has an opening for a metallurgical engineer as sales manager. Requirements include basic knowledge of mechanical engineering and metal-working methods together with some sales experience in similar or heavy machinery line. Send outline of qualifications, addressing Box A, ASTM BULLETIN.

B.—Young man for physical and chemical testing in cellulose plastics industry. Permanent position in modern laboratory located in Delaware. Send full details, including age, education, experience, and salary expected. Address Box B, ASTM BULLETIN.

TECHNICAL SERVICES AVAILABLE

1.—Spectrographer with about one year's service in a defense plant. Has a B.S. Degree with a major in chemistry. Writes from Chicago. Box 1, ASTM BULLETIN.

2.—Physicist, who was ballistician and later quality superintendent at midwest ordnance plant. Prewar experience in textile and rubber research which included work on application of statistical control methods. Has Ph.D. degree. Age, 39 years. Box 2, ASTM BULLETIN.

Industrial Research Institute

AT THE meeting of the Industrial Research Institute in New York in September, several interesting papers were presented on problems in this field, including one by J. H. Schaefer of the Ethyl Corp., dealing with public relations and industrial research. This subject is to be covered in one of the chapters of a monograph to be published by the Institute covering "Management of Industrial Research."

This Institute was founded in 1938 and incorporated this year under the laws of New York state. The purposes of the Institute are to promote improved management of industrial research, to develop an understanding of research as a force in the life of the nation, and to promote high standards in the field of industrial research.

Many A.S.T.M. members are active in the Institute and some are officers, including the following: A. G. Ashcroft, Alexander Smith and Sons Carpet Co.; R. T. K. Cornwell, Sylvania Industrial Corp., and H. K. Work, Jones & Laughlin Steel Corp.

This rather striking photograph of the Rock Island Centennial Bridge over the Mississippi River is of interest from more than the aesthetic and practical standpoint. We have been advised through the courtesy of the American Institute of Steel Construction and the designing engineers that the following A.S.T.M. specifications were used to cover important materials in the bridge:

Open-Hearth Structural Steel	A-7
Silicon Steel (Bridge Chords)	A-94
Wrought Iron	A-42
Steel Castings	A-27
Rivet Steel	A-141
Alloy Steel Castings	A-148
Steel Forgings	A-18
Structural Wood	D-245
Sewer Brick	C-32
Portland Cement (High Early Strength)	C-9
Portland Cement	C-74
Hydraulic Cement	C-77
Zinc Coatings	A-123
Electrodeposited Cadmium Coatings	A-165
Concrete	D-138
Fine and Coarse Aggregates	C-41
Sands for Concrete	C-40
Concrete Aggregates	C-33

Designed by the firm of Howard, Needles, Tammen and Bergendoff, Kansas City, which organization has designed several other Mississippi bridges in the last few years (Natchez, Greenville, and Dubuque), the Rock Island bridge was fabricated by the American Bridge Co. The illustration is by courtesy of the American Institute of Bolt, Nut and Rivet Manufacturers, having been used in their magazine, *Fasteners*. The two Institutes, Mr. Howard, and the fabricating company all participate in A.S.T.M. work.

NEW MEMBERS TO OCTOBER 2, 1945

The following 88 members were elected from July 20 to October 2, 1945:

Names are arranged alphabetically—company members first, then individuals.

Chicago District

BACH, RALPH V., Assistant Plant Manager, The Indiana Steel Products Co., Valparaiso, Ind.

LAMAR, CHARLES C., JR., Chief Engineer, Harper-Wyman Co., 8562 Vincennes Ave., Chicago 20, Ill.

LIEBER, EUGENE, Technical Director, Nox-Rust Corp., 2429 S. Halsted St., Chicago 8, Ill.

LOWE, MELVILLE, Metallurgist, Lowe Laboratories, 1141 N. Van Buren St., Milwaukee 2, Wis.

WASIELEWSKI, E. W., Chief Engineer, B-W Superchargers, Inc., 2420 W. Capitol Dr., Milwaukee 9, Wis.

Cleveland District

CHASE BAG CO., C. P. Spring, Chief Chemist, Mill and Cleveland Sts., Chagrin Falls, Ohio.

PESCO PRODUCTS CO., ENGINEERING LIBRARY, Norman B. Dewees, Research Engineer, 11610 Euclid Ave., Cleveland 6, Ohio.

HARRIS, GEORGE R., Partner, Garfield, Harris, Robinson & Schafer, 915 National City Bank Bldg., Cleveland 14, Ohio.

LYMAN, TAYLOR, Editor, *Metals Handbook*, American Society for Metals, 7301 Euclid Ave., Cleveland 3, Ohio. For mail: 6822 Fleet Ave., Cleveland 5, Ohio.

Detroit District

COMMERCIAL STEEL TREATING CORP., Ralph J. Hoensheid, President, 6100 Tireman Ave., Detroit 4, Mich.

MILLER, J. MUSSER, Chief Engineer, Standard Oil Co. (Ind.), Box 2858, Detroit 31, Mich.

New York District

EASTERN METAL PRODUCTS CO., Louis T. Friedman, Metallurgist, Tuckahoe, N. Y.

FOSTER ENGINEERING CO., C. E. Johnson, Chief Engineer, 109 Monroe St., Newark 1, N. J.

L.A.B. CORPORATION, B. A. Wittkuhns, President and General Manager, Summit, N. J.

MAGUIRE INDUSTRIES, INC., NOSTRIP DIVISION, Francis L. Mark, Bituminous Technologist, 122 E. Forty-second St., New York 17, N. Y.

WESTCOTT & MAPES, INC., Willis F. Thompson, Chief Mechanical Engineer, 109 Church St., New Haven, Conn.

ABBERLEY, E. K., Engineer, Turner Construction Co., 420 Lexington Ave., New York 17, N. Y.

BRAININ, C. S., Partner and Manager, C. S. Brainin Co., 233 Spring St., New York 13, N. Y.

COOPER, W. L., President, Robert W. Hunt Co., Engineers, 59 Murray St., New York 7, N. Y.

FENTON, JOHN V., President, Carman-Dunne, Inc., 46 Atlantic Ave., Lynbrook, N. Y. For mail: 410 Morris Ave., Rockville Centre, N. Y.

LAWSON, GEORGE R., Technical Representative, The Barrett Division, Allied Chemical and Dye Corp., 40 Rector St., New York 6, N. Y. For mail: One Garrett Place, Bronxville 8, N. Y.

NEW YORK CITY, DEPARTMENT OF PARKS, Stuart Constable, Chief Park Designer, The Arsenal, Central Park, Sixty-fourth St. and Fifth Ave., New York, N. Y.

O'HARE, EUGENE R., Technical Director, Casein Co. of America, Division of The Borden Co., 350 Madison Ave., New York 17, N. Y. For mail: 145 E. Nineteenth St., New York 3, N. Y.

POSTLE, ALBERT H., Standards Engineer, Sperry Gyroscope Co., Inc., Garden City, N. Y. For mail: 126 Chestnut St., Garden City, N. Y.

PRICE, DONALD, Technical Director, Oakite Products, Inc., 22 Thames St., New York 6, N. Y. For mail: 166 E. Ninety-sixth St., New York 28, N. Y.

SMITH, B. R., Chief of Packaging, New York Ordnance District, U. S. Army, 80 Broadway, New York, N. Y. For mail: 94-44 Plattwood Ave., Ozone Park, L. I., N. Y.

VEGOSEN, JEROME, Draftsman, Consolidated Machine and Design Co., Inc., 9 E. Fifty-ninth St., New York 22, N. Y. For mail: 1564 Walton Ave., New York 52, N. Y. [J]*

WARING, ROBERT W., Chief Engineer, Bridgeport Brass Co., East Main Plant, Bridgeport 2, Conn.

Northern California District

BRYANT, AUSTIN, Chief Engineer, Grove Regulator Co., 6529 Green St., Oakland 8, Calif. For mail: 2829 Forest Ave., Berkeley 5, Calif.

Philadelphia District

PERKINS GLUE CO., E. F. Gould, Vice-President, Cannon Ave., Lansdale, Pa.

BENNETT, EDMUND V., Assistant Metallurgical Engineer, Bethlehem Steel Co., Inc., Bethlehem, Pa. For mail: 1742 Cloverleaf St., Bethlehem, Pa.

BOLGER, ARTHUR F., Partner and Manager, General Textile Machinery Co., 1139 E. Chelten Ave., Philadelphia 38, Pa.

MANLEY, LAURENCE B., Specification Writer, Philadelphia Department of City Transit, 1314 City Hall Annex, Philadelphia 7, Pa.

ROSTLER, FRITZ S., Research Professor of Chemistry, University of Delaware, Newark, Del.

Pittsburgh District

PITTSBURGH COAL CARBONIZATION CO., Benjamin W. Jones, Chief Chemist, R. D. 1, McDonald, Pa.

EVANS, C. T., JR., Chief Metallurgist, Elliott Co., Jeannette, Pa. For mail: Box 136, Delmont, Pa.

FETH, GILBERT, Follansbee Steel Corp., Follansbee, W. Va.

POTTER, C. L., Supervisor of Coal and Coke Research, Jones & Laughlin Steel Corp., Hazelwood By-Product, 39 Longworth St., Pittsburgh 21, Pa.

Southern California District

FOOD MACHINERY CORP., ENGINEERING DIVISION, C. C. Woolsey, Metallurgist, 6000 N. Figueroa, Los Angeles 42, Calif.

NOBLE, L. DEANE, Director of Product Development Lab., North American Aviation, Inc., Imperial Blvd., Inglewood, Calif.

Western New York-Ontario District

DEARBORN CHEMICAL CO., LTD., H. N. Potter, Technical Director, 2454 Dundas St. West, Toronto, Ont., Canada.

SPENCER KELLOGG AND SONS, INC., Robert L. Terrill, Chemist, Box 989, Buffalo 5, N. Y.

CLARK, PAUL C., Production Chemist, Fedders Manufacturing Corp., 57 Tonawanda St., Buffalo 7, N. Y. For mail: 93 Highland Ave., Hamburg, N. Y.

MARRA, ALAN A., Director, Sales Service Lab., Laucks, Inc., Lockport, N. Y.

POLETIKA, NICHOLAS V., Senior Process Engineer, Curtiss-Wright Corp., Airplane Div., Research Lab., Buffalo 5, N. Y.

REID, JOHN O., Research Fellow, Alfred University, Box 273, Alfred, N. Y.

U. S. and Possessions

BROWN RUBBER CO., INC., C. Vaughn Castor, Chief Chemist, Box 1000, Lafayette, Ind.

CABOT CARBON CO., RETORT CHEMICAL DIVISION, L. W. Mims, Plant Manager, Box 137, Gainesville, Fla.

CROWN MANUFACTURING CO., Kenneth B. Cook, Vice-President and General Manager, Pawtucket, R. I.

GENERAL MILLS, INC., RESEARCH DEPT., August S. Ries, Jr., Test Engineer, 1837 Pierce St., N. E., Minneapolis 13, Minn.

NASHUA GUMMED AND COATED PAPER CO., Lloyd M. Perry, Chief Chemist, 44 Franklin St., Nashua, N. H.

NATIONAL WOODEN BOX ASSN., C. D. Hudson, Executive Vice-President and Manager, 308 Barr Bldg., Washington 6, D. C.

PORCELAIN PRODUCTS, INC., C. F. Schimke, Chief Engineer, Box 830, Parkersburg, W. Va.

VALLEY RESEARCH CORP., Frans V. E. Vaurio, Director of Chemical Lab., Montague, Mich.

ABRAMOWITZ, WILLIAM L., President, American Resinous Chemicals Corp., 103 Foster St., Peabody, Mass.

HARTMAN, CHARLES C., Chemist, National Bureau of Standards, Washington 25, D. C. For mail: 7223 Bradley Blvd., Bethesda 14, Md.

HIRASHIMA, K. B., Materials Testing Engineer, Territorial Highway Dept., Box 162, Honolulu, Oahu, Hawaii.

INDIA SUPPLY MISSION, G. D. Meadows, Librarian, 635 F St., N. W., Washington 4, D. C.

LADD, H. W., Superintendent of Materials, Stanolind Oil and Gas Co., Box 591, Tulsa 2, Okla.

MARBURY, D. H., Purchasing Agent, City of Birmingham, 302 City Hall Bldg., Birmingham 3, Ala.

MARYLAND STATE DEPARTMENT OF HEALTH, George L. Hall, Chief Engineer, 2411 N. Charles St., Baltimore 18, Md.

MEYN, M. A., Manager, New Orleans Branch, Pittsburgh Testing Laboratory, 816 Howard Ave., New Orleans 13, La.

MURRAY, WILLIAM M., JR., Analytical Chemist, Southern Research Inst., 917 S. Twentieth St., Birmingham 5, Ala.

NELSON, V. B., Consulting Engineer, 2132 Commerce Bldg., Houston 2, Tex.

NEWMARK, NATHAN M., Research Professor of Civil Engineering, University of Illinois, 111 Talbot Lab., Urbana, Ill.

POPE, R. C., Chemical Engineer, The Pope Testing Laboratories, Box 903, Dallas 1, Tex.

SCHRADER, O. HARRY, JR., Chief Wood Technologist and Research Engineer, Timber Structures, Inc., 5035 First Ave. S., Seattle 4, Wash.

SCOTT, ARNOLD H., Physicist, National Bureau of Standards, 216 East Bldg., Washington 25, D. C.

SEAMAN, WILLIAM STANLEY, Technical Director, Angier Sales Corp., Fountain St., Framingham, Mass.

SIESS, CHESTER P., Special Research Associate in Theoretical and Applied Mechanics, University of Illinois, 103 Talbot Lab., Urbana, Ill.

TAYLOR, MALCOLM L., Technical Director, Union Bag and Paper Corp., Savannah, Ga.

TEICH, FREDERIC C., Architect, 252 Asylum St., Hartford 3, Conn.

TUTHILL, HAROLD A., Manager, Chemical Research Inst., Box 361, Coral Gables, Fla.

UNIVERSITY OF COLORADO LIBRARIES, Boulder, Colo.

WRIGHT, KENNETH W., Superintendent, Ash Grove Lime and Portland Cement Co., Chanute, Kans.

Other than U. S. Possessions

AERO RESEARCH, LTD., N. A. de Bruyne, Hinxton Rd., Duxford, Cambridge, England.

DE LA RUE PLASTICS, LTD., R. B. Harley, Chief Chemist, Avenue Works, Walthamstow Ave., London, E. 4, England.

NEW ZEALAND RAILWAYS, General Manager, Private Bag, Wellington, New Zealand.

WEST OF SCOTLAND IRON AND STEEL INST., 39 Elmbank Crescent, Glasgow, C. 2, Scotland.

AUSTRALIA BUILDING MATERIALS RESEARCH, Officer in Charge, 69–77 Yarra Bank Rd., South Melbourne S. C. 4, Victoria, Australia.

BOGEHOLD, HERMAN ANDERS, Chief Chemist, Abasand Oils, Ltd., Fort McMurray, Alta., Canada.

BRITISH COAL UTILISATION RESEARCH ASSN., THE, Librarian, 13, Grosvenor Gardens, London, S. W. 1, England.

* [J]—Denotes Junior Member.

GEARY, D. S., Manager, Queensland Cement and Lime Co., Ltd., Darra, Brisbane, Australia.

HANDA, C. L., RAI BAHADUR, I. S. E., Designing and Construction Engineer, Punjab Irrigation Dept., Lahore, India.

HEBREW INSTITUTE OF TECHNOLOGY, BUILDING MATERIALS TESTING LAB., Haifa, Palestine.

MARTIN, MARCEL, Physicist, Physique et Industrie, 17 Rue des Gobelins, Paris XIII, France.

RICHER, GEORGE CODLING, Consultant on Research and Development, John Lysaght, Ltd., Orb Iron Works, Newport, Mon., England.

TAYLOR, FRANK, Chief Chemist, J. V. Rushton (London) Ltd., Whitcher Pl., Camden Town, London, N. W. 1, England. For mail: 113 Amberley Rd., Bush Hill Park, Enfield, Middlesex, England.

Personals. . .

. . .News items concerning the activities of our members will be welcomed for inclusion in this column.

CHARLES ROBERTS, formerly Engineer, Toolthrift Co., Pittsburgh, Pa., is now Engineer, The McCormick Co., Pittsburgh, Pa.

FREDERICK C. THORN, who is active in A.S.T.M. technical work, especially in Committee D-11 on Rubber Products, has been appointed Research Director, The Garlock Packing Co., Palmyra, N. Y. For some years he has been chief chemist with the company.

BURT WETHERBEE, who was connected with the American Resinous Chemicals Corp., Peabody, Mass., as Manager, is now with the General Latex and Chemical Corp., as Mid-West Technical Representative, located in Snyder, N. Y.

RALPH T. K. CORNWELL is now Director of Research at the Sylvania Industrial Corp., Fredericksburg, Va.

T. SMITH TAYLOR, formerly Chief Engineer and in Charge of Development Department, Selenium Rectifier Division, Federal Telephone and Radio Corp., East Newark, N. J., is now with the United States Testing Co., Inc., Hoboken, N. J.

J. K. RUMMEL, who was the representative of the Shanghai Power Co. in its Society membership until that company's operations were suspended due to the war, will return shortly to China and resume his work with the company. His address will be 181 Nanking Road, Shanghai, China. Mr. Rummel, who holds personal membership in the Society, has spent considerable time in the past two years in Cuba, Mexico, Panama, and Colombia.

ROLLAND H. SOLL, formerly General Manager, White Heat Treating Co., Huntington Park, Calif., is now Chief Metallurgist, Warman Steel Casting Co., Huntington Park.

LOUIS KRISTOFF, who was Foundry Metallurgist, Reynolds Metals Co., Springfield, Mass., is now Chief Metallurgist, The Aluminum Heat Treating Co., Cleveland, Ohio.

RALPH S. HOLT is now Co-owner, Ralph S. Holt Testing Laboratory, New Orleans, La. He was New Orleans Representative, Pittsburgh Testing Laboratory, New Orleans, La.

T. E. ALLEN, who was Secretary-Manager, American Automobile Association, Washington, D. C., is now Commissioner, Brake Lining Manufacturers' Association, Inc., New York, N. Y.

J. LEWIS LUCKENBACH is now Structural and Mechanical Engineer, Anaconda Copper Mining Co., New York, N. Y. He was with Hardy S. Ferguson and Co., Inc., New York.

ERNEST B. RUBLOFF is returning to private consulting practice (Consulting Chemist) with laboratories and office at 7425 Sunset Boulevard, Hollywood, Calif.

L. P. KONGSTED is now Manager of Engineering Research of the American Bosch Corp., Springfield, Mass.

EDWARD A. ABDUN-NUR, formerly Paving and Materials Engineer, U. S. Engineer Office, Denver, Colo., is now Engineer, U. S. Bureau of Reclamation, Denver, Colo.

BERNARD J. HIGGINS is connected with the Agaloy Tubing Co., Springfield, Ohio, as General Superintendent. He was formerly Superintendent and Chief Metallurgist, Linderme Tube Co., Euclid, Ohio.

ALBERT L. KAYE, who was Metallurgical Engineer, Carnegie-Illinois Steel Corp., Pittsburgh, Pa., is now Vice-President and General Manager, Beckman Supply Co., Hammond, Ind.

MAURICE E. GILMORE is now Director of Transportation, Office of Inter-American Affairs, Washington, D. C. He was Civil Engineer, Commissioner of Public Works Administration, Washington.

E. V. ROMAINE, who was Manager, Technical Sales, Naval Stores Division of The Glidden Co., New York, N. Y., is now with the Carmody Research Laboratories, Inc., Philadelphia, Pa.

W. C. DEVEREUX is Chairman, International Alloys, Ltd., Slough, Bucks, England. He was formerly Managing Director, High Duty Alloys, Ltd., in Slough.

KENNETH B. COOK, formerly Vice-President in Charge of Manufacturing, Manville-Jenckes Corp., Manville, R. I., is now Vice-President and General Manager, Crown Manufacturing Co., Pawtucket, R. I.

LLOYD F. RADER has returned to the University of Wisconsin Department of Civil Engineering after a leave of absence serving as Lieutenant Commander, U.S.-N.R., Office of Director, Pacific Division, Bureau of Yards and Docks, U. S. Navy Department, San Francisco, Calif.

J. H. CONZELMAN is now President of Alabama Asphaltic Limestone Co., Birmingham, Ala. He was formerly Vice-President.

HENRY SANG who has been connected with the Aeronautical Materials Laboratory, Naval Air Experimental Station, Naval Air Material Center, Philadelphia, Pa., as Materials Engineer, is dropping his technical work and is going to California to take up writing.

ANDREW LUNDTEIGEN, JR., formerly Chemical Engineer, and Assistant Superintendent, is now Chemical Engineer, and Superintendent, Louisville Plant, Ash Grove Lime and Portland Cement Co., Louisville, Nebr.

WALTER J. McCOY has been appointed Manager of Research Laboratory of Lehigh Portland Cement Co., Allentown, Pa. He has been affiliated with Lehigh since 1938 and was Research Chemist from 1940 to the present time. During the war period he taught evening extension classes for Pennsylvania State College in engineering, chemistry, and instrumentation.

E. C. WILLIAMS has resigned as Vice-President and Director of Research of General Aniline and Film Corp., Easton, Pa. He will continue as Consultant to President in technical and development matters.

BENJAMIN S. GARVEY, JR., formerly with The B. F. Goodrich Co., Akron, Ohio, has been appointed Technical Service Manager on Rubber Chemicals, B. F. Goodrich Chemical Co., Cleveland, Ohio.

W. R. SHIMER, Metallurgical Engineer in Charge of Sheet, Strip and Tin Mill Products, Bethlehem Steel Co., Bethlehem, Pa., has retired from the company after a notable period of service of 38 years. During his years with Bethlehem Steel Mr. Shimer had a part in originating and developing many metallurgical advances. He also in 1912 participated in instituting the metallographic department, forerunner and nucleus of the present metallurgical department, and in establishing the company's observer system.

J. H. WALKER, Vice-President, The Detroit Edison Co., Detroit, Mich., is one of the group named to raise the funds for the enlarged program of research at the laboratory of The American Society of Heating and Ventilating Engineers in Cleveland and in cooperating institutions.

JOHN HOWE HALL, lately metallurgist, General Steel Castings Co., writes that effective October 1 he resumed consulting practice with General Steel Castings Co. as a regular client.

GENERAL ELECTRIC X-RAY. CORP., Chicago, is moving its main office from its plant at 2012 Jackson Boulevard, to the Insurance Exchange Building, 175 Jackson Boulevard.

CYRIL STANLEY SMITH has resigned from his position as Research Metallurgist for the American Brass Co., Waterbury, Conn., to accept appointment as Professor of Metallurgy and Head of the newly formed Institute for the Study of Metals at the University of Chicago. He has been on leave of absence from American Brass for war work since early in 1942, at first as Research Supervisor for the War-Metallurgy Committee of the National Research Council, and since April, 1943, with the Los Alamos atomic

bomb project near Santa Fe, New Mexico. He will not take up residence in Chicago for a few months, pending reorganization of the work at Santa Fe.

CARL C. HENNING became Manager of Raw Materials, Jones & Laughlin Steel Corp., Pittsburgh, Pa., effective August 1. He had been General Metallurgist of the corporation.

EARNSHAW COOK for many years Metallurgist in the Metallurgical Department, American Brake Shoe Co., Mahwah, N. J., is resigning from this position on January 1, 1946. He will continue in a consulting capacity with the company and will engage in a limited amount of general consulting work on steel mill and foundry problems, but he expects to make his permanent residence at his farm on Kent Island, Md., just across the Chesapeake from Annapolis. *Mining and Metallurgy* reports that at the farm he expects to catch up on a lot of loafing, reading, fishing, cruising, and duck shooting, to try his hand at writing a metallurgical case book including a number of presumably interesting adventures in process metallurgy and later, perhaps, to open a modest consulting office for weak moments in Baltimore.

S. S. STEINBERG, Dean, College of Engineering, University of Maryland, College Park, Md., is making a three-month good-will tour of Latin-American countries in behalf of engineering education. His trip is being sponsored by the U. S. Department of State through its Division of Cultural Cooperation. A note from Dean Steinberg indicates he has noted interest in A.S.T.M. standards and it is hoped later on the BULLETIN can carry some news notes from him about his trip.

G. T. JOHNSON has been elected President and General Manager, The Buckeye Steel Castings Co., Columbus, Ohio. He was formerly First Vice-President of the company.

SHORTRIDGE HARDESTY announces the formation of an engineering partnership with Clinton D. Hanover, Jr., under the name of Hardesty and Hanover, succeeding to the practice of Waddell and Hardesty. Their offices will be at 101 Park Ave., New York 17, N. Y.

HERBERT J. FRENCH, Assistant Manager, Steel Division, War Production Board, Washington, D. C., has returned to The International Nickel Co., New York N. Y.

HENRY A. GARDNER who has been active for many, many years in the Society, particularly in connection with its work on paint, varnish, lacquer and related materials in Committee D-1, has announced his retirement as of July 1 from the Scientific Section of the National Paint, Varnish and Lacquer Association, Inc., after 38 years of active service in the industry. GEORGE G. SWARD, who for 20 years has worked closely with Dr. Gardner, has been named Assistant Director of the Scientific Section. Dr. Gardner's name will continue to appear as Director of the Section until that position is filled by subsequent appointment.

C. G. A. ROSEN, Director of Research, Caterpillar Tractor Co., Peoria, Ill., is serving on temporary duty as a special technician on investigative work for the U. S. Navy Department.

The I.E.S. Gold Medal, given by the Illuminating Engineering Society as highest honor in the field of lighting, has been awarded to Preston S. Millar, President, Electrical Testing Laboratories, Inc., New York, N. Y. This medal is awarded to eligible candidates from the fields of engineering, design, applied illumination, optics, ophthalmology, lighting research, education or administration "in recognition of meritorious achievement which has conspicuously furthered the profession, art, or knowledge of illuminating engineering."

E. J. HERGENROETHER, recently resigned Chief of the Metallurgical Branch of the Steel Division of the WPB in Washington, D. C., has resumed his duties with the Development and Research Division of the International Nickel Co., Inc., New York. He will be in charge of the Division's automotive steel development and will make his headquarters in Detroit.

A. D. SHANKLAND, formerly Engineer of Tests, Bethlehem Steel Co., Inc., Bethlehem, Pa., is now Assistant General Manager of the Bethlehem Plant.

LESTER A. LANNING, who was Metallurgist, New Departure Division, General Motors Corp., Bristol, Conn., has been named Plant Manager of the General Motor's Sandusky Plant which is to be constructed as soon as conditions permit.

H. P. HASS has been appointed Director of Tests and Research of the New York, New Haven and Hartford Railroad Co., New Haven, Conn. He was formerly Engineer of Tests.

At a recent meeting, several A.S.T.M. members were elected to office in the Wisconsin Chapter of the American Foundrymen's Association as follows: *Vice-President:* DAVID ZUEGE, Technical Director, Sivyer Steel Casting Co., Milwaukee, Wis.; *Director:* ROBERT C. WOODWARD, Chief Metallurgist and Superintendent of Foundries, Bucyrus-Erie Co., South Milwaukee, Wis.

Several A.S.T.M. members were elected as officers of the American Welding Society at its annual meeting, as follows: *President:* WENDELL F. HESS, Associate Professor of Metallurgical Engineering, and Head of Welding Laboratory, Rensselaer Polytechnic Institute, Troy, N. Y.; *First Vice-President:* HAROLD O. HILL, Assistant Chief Engineer, Fabricated Steel Construction, Bethlehem Steel Co., Bethlehem Pa.; *Directors at Large:* A. B. KINZEL, Vice-President, Electro Metallurgical Co., New York, N. Y.; C. M. UNDERWOOD, Manager, Welding Department, Northern Pump Co., Minneapolis, Minn.; R. D. THOMAS, President, Arcos Corp., Philadelphia, Pa.

Also, Professor HESS and B. L. AVERBACH, Metallurgical Engineer, General Electric Co., Schenectady, N. Y., were awarded a prize sponsored by the Resistance Welding Manufacturers Association for the best paper from a university source, the paper entitled "The Surface Treatment at Room Temperature of Aluminum Alloys for Spot Welding." SAMUEL L. HOYT, Technical Adviser, Battelle Memorial Institute, Columbus, Ohio, delivered the Adams Lecture before a large audience of members and guests at the meeting, and L. C. BIBBER, Welding Engineer, Carnegie-Illinois Steel Corp., Pittsburgh, Pa., received this year's award of the Lincoln Gold Medal and Certificate. Two A.S.T.M. members were presented with certificates of Honorary Membership, as follows: DAVID S. JACOBUS, Advisory Engineer, The Babcock & Wilcox Co. (Retired), Montclair, N. J., and H. C. BOARDMAN, Research Engineer, Chicago Bridge and Iron Co., Chicago, Ill.

B. H. DELONG, who has been active in the work of the Society including the Committee on Steel and on Iron-Chromium-Nickel and Related Alloys, has been made a Director and Vice-President of the Carpenter Steel Co. For a number of years, Mr. DeLong was Chief Metallurgist. Paul B. Greenawald also has been made Director and Vice-President.

J. H. DEPPELER, Chief Engineer of the Metal & Thermit Corp., New York, N. Y., has been elected an honorary life member of the American Welding Society and has been selected to receive the Miller Medal this year for outstanding work contributing to the art of welding. Since its establishment in 1927, the Miller Medal has been awarded annually by the American Welding Society to an engineer or scientist contributing conspicuously to the advancement of the art of welding and cutting. Mr. Deppeler, one of the founders of the Welding Society, its first vice-president and second president, is chairman of the Joint A.W.S.-A.S.T.M. Committee on Filler Metal which has numerous projects under way involving specifications and tests for the various materials in this field.

EDWARD DAHILL, Chairman of A.S.T.M. Committee D-10 on Shipping Containers, whose headquarters as Chief Engineer of the Freight Container Bureau, Association of American Railroads, were in New York City, has recently transferred his headquarters and staff to Chicago. He continues as Chief Engineer of the Freight Loading and Container Section of the A.A.R., with offices at 59 E. Van Buren St., Chicago, Ill.

GREENWOOD H. NOWLIN, JR., formerly President of Premier Pocahontas Collieries Co., Premier, Va., which organization was voluntarily liquidated a few years ago, has an office as a Manufacturer's Representative at Room 501, Peoples National Bank Building, Lynchburg, Va.

T. S. FULLER, formerly Engineer of Materials, Works Laboratory, General Electric Co., Schenectady, N. Y., has been appointed Engineer in Charge of the Works Laboratory. Mr. Fuller who has been very active in many phases of A.S.T.M. work has spent his entire career in engineering with General Electric, and has seen 34 years of service with the firm.

The Manufacturers Standardization Society of the Valve and Fittings Industry has announced the retirement of its General Secretary, JOHN J. HARMAN, and the appointment of LESTER W. BENOIT as MSS secretary. Mr. Harman plans to spend his retirement in Southern California. This society has been much interested in the work of A.S.T.M. and also participates actively in committees functioning under the sponsorship of the American Standards Association.

R. M. WILHELM, formerly Technical Adviser and Sales Manager, Laboratory Instrument Division of C. J. Tagliabue Manufacturing Co., Brooklyn, N. Y., is now associated with Miller & Weber, manufacturers of precision thermometers and hydrometers, 71-14 Myrtle Ave., Glendale, Long Island, N. Y.

R. A. SCHATZEL has been appointed Vice-President and Director of Engineering of the Rome Cable Corp. with offices in Rome, N. Y. Mr. Schatzel, who was formerly connected for many years with the Rome Wire Co., has more recently been Director of Research for the General Cable Corp. in Bayonne. Extremely active in the work of many organizations he has rendered notable service to A.S.T.M. in his capacity as chairman for many years of the Committee on Insulated Wires and Cables functioning under Committee D-11 on Rubber Products. This group had many perplexing problems during the wartime because of the rubber situation. Mr. Schatzel had important assignments in the War Production Board work in Washington, and recently has returned from a trip of many weeks in Europe.

DOUGLAS E. PARSONS, who has headed the Section on Masonry Construction, National Bureau of Standards, has been named Chief of the Bureau's Division of Clay and Silicate Products succeeding A.S.T.M. Past-President P. H. Bates, whose retirement is announced elsewhere in this BULLETIN. A member of the A.S.T.M. since 1924, Mr. Parsons has been very active in important phases of its work, particularly the committees covering building units, brick, tile, etc., and since 1937 he has been chairman of Committee C-15 on Manufactured Masonry Units. He serves on several other A.S.T.M. groups and has recently been appointed temporary chairman of a new committee concerned with asbestos-cement products. A native of Iowa where he attended Cornell College, he served abroad in World War I, and has been at the Bureau since 1923. Mr. Parsons is now serving as president of the American Concrete Institute and it is of interest to note that in 1936 he was the joint recipient of the A.C.I. Wason Medal for outstanding research. This was presented by the then A.C.I. President, P. H. Bates.

NECROLOGY

(Dates of death are given where available)

THOMAS R. AKIN, President, Laclede Steel Co., St. Louis, Mo. Founder and long-time president of Laclede, Mr. Akin was much interested in A.S.T.M. work and had been affiliated with the Society since 1912. (August 8, 1945.) W. W. Scott, Jr., Vice-President of the Company, continues as the representative of the Sustaining Membership.

GUY O. GARDNER, Superintendent, Ash Grove Lime and Portland Cement Co., Chanute, Kans. Member since 1930. Member of Committee C-1 on Cement for ten years, he had been active in the work of the Sponsoring Committees on Portland Cement and on Blended Cements, and also served on A.S.T.M. Committee C-7 on Lime. Affiliated with his company since 1912, he had been Superintendent of the Chanute Plant from 1925 until he was appointed Production Manager the first of this year. He was very active in fraternal and civic affairs. (August 5, 1945.)

ROBERT B. HARPER, Vice-President, The Peoples Gas Light and Coke Co., Chicago, Ill. A member of the Society since 1915, Mr. Harper had been continuously interested in the Society's work. Formerly a member of Committee D-2 on Petroleum Products and Lubricants, he was serving at the time of his death as a member of Committee A-3 on Cast Iron, and had been one of the strong supporters of Committee D-3 on Gaseous Fuels where he served on the Advisory Committee and was chairman of its Subcommittee III on Determination of Calorific Value of Gaseous Fuels. He had been a member of the A.S.T.M. Chicago District Committee for ten years. An outstanding authority in his field, he had been Vice-President of his company since 1930. He received several honors including medals from the Franklin Institute, the gas industry, and the American Institute of Chemists. He was the second Vice-President of the Western Society of Engineers at the time of his death. (August 29, 1945.)

DOUGLAS A. MACCALLUM, Consulting Chemist and Metallurgist, Glasgow, Scotland. Member since 1918. (January, 1945.)

J. C. OGDEN, President, Robert W. Hunt Co., New York, N. Y. A personal member of the Society since 1924, he had also at one time represented his company's membership. (September 10, 1945.)

C. B. WING, Consulting Civil Engineer, and Professor of Structural Engineering, Emeritus, Stanford University, Palo Alto, Calif. One of the very early members of the Society, Professor Wing had been affiliated since 1900. At one time he was active in the work of Committee C-10 on Hollow Masonry Building Units, serving on several of its subcommittees. (August 22, 1945.)

Catalogs and Literature Received

GEORGE SCHERR CO., INC., 200 Lafayette St., New York 12, N. Y. A four-page folder describing the Scherr Magni-Ray for use in all kinds of inspection work. Illustrated. Order blank and prices included.

F. J. STOKES MACHINE CO., 5932 Tabor Road, Philadelphia 20, Pa. A 78-page book on "Manufacture of Compressed Tablets" covering tabletting methods and technique which are applicable not only to pharmaceuticals, but the food, medical, and other fields. Page size 4¾ by 7¼ in., illustrated. Available from "Drug and Cosmetic Industry," 101 W. Thirty-first St., New York 1, N. Y., at $3 per copy.

W. A. TAYLOR & CO., 7300 York Road, Baltimore 4, Md. "Modern pH and Chlorine Control," an 88-page book in its seventh edition covering pH control, colorimetric methods, various comparators, slides, testers, and sets. There is an extensive section on applications ranging from air conditioning to water treatment. Also a section on precautions and one on theory of electrolytic disassociation. This book should be of much interest and service to those concerned with this field.

HARRY W. DIETERT CO., 9330 Roselawn Ave., Detroit 4, Mich. A four-page folder entitled "Two-Meter Spectrograph" No. 2100, a new instrument which can be supplied with 36,600 lines per inch or 91,500 total grating lines, representing an unusually fine ruling. Illustrated.

W. H. & L. D. BETZ, Gillingham and Worth Sts., Philadelphia 24, Pa. Literature is available from this company on a new nitrate ion comparator which should be of interest to all those concerned with boiler waters, embrittlement, etc.

ENGINEERS SPECIALTIES DIVISION OF THE UNIVERSAL ENGRAVING AND COLORPLATE CO., INC., 980 Ellicott St., Buffalo 8, N. Y. Literature is available on a new scale recently completed for those employing the optical projection method of inspection. Also, a four-page folder describing "Detail Engineers' Glass and Universal Layout Scale for Form Grinders 50 to 1 Magnification." Illustrated.

TABER INSTRUMENT CORP., 111 Goundry St., North Tonawanda, N. Y. Literature describing a special shear, the new triple cut specimen shear which is designed and manufactured as a companion piece to Taber V-5 stiffness gage.

LEEDS & NORTHRUP CO., 4934 Stenton Ave., Philadelphia 44, Pa. Catalog E-54 (2) entitled "Modified Schering Bridge," ten pages, replaces an earlier catalog (1937) and has been completely revised including photographs, photo-diagrams, and descriptive material.

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Inspections, Testing and Chemical Work
Fort Worth, Dallas, Houston, Corpus Christi, and San Antonio, Texas

W. B. COLEMAN & CO.
Metallurgists-Chemists-Engineers
Spectroscopic Analysis
Chemical and Physical Testing
Metallurgical Investigations
Boiler Water Conditioning
Consultation Service
9th & Rising Sun Ave., Philadelphia 40, Pa.

UNITED STATES TESTING CO. INC.
HOBOKEN, N. J.
Est. 1880 *Scientific Testing* *Research Analysis*
Consultation and Inspection Service
PHILA.•N. Y.•CHICAGO•BOSTON•WOONSOCKET

THE WAYNE LABORATORIES
Chemists Bacteriologists Consultants
Research and Control for Post War Prosperity
17 E. Main St. Waynesboro, Pa.

THE JAMES H. HERRON COMPANY
Engineers, Chemists, Metallurgists
Consulting, Inspecting, Testing
Physical, Chemical, Metallographical & X-Ray Laboratories
1360–1364 West Third St., Cleveland, Ohio

FATIGUE AND VIBRATION
RESEARCH AND TESTING LABORATORY
SONNTAG SCIENTIFIC CORPORATION
16 Seneca Place
Greenwich, Connecticut

PATZIG TESTING LABORATORIES
ENGINEERING INSPECTION
TESTS · ANALYSES · RESEARCH
—OF—
EQUIPMENT · APPLIANCES
MATERIALS & PRODUCTS
Ingersoll Ave. & 23rd St. Des Moines, Iowa

A. W. WILLIAMS INSPECTION COMPANY
Timber and Timber Treatment Inspections
Also
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